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Enter—The Metallurgist

One of the most active phases of the electroplating industry at the present time is in the field of alloy deposition, as is evidenced by the number of papers presented before various technical societies and the increased number of patents granted in this field. While some of these alloy deposits are intended to supplement the more common deposits for appearance and cost considerations only, most have been developed with more specific functional applications in mind, such as resistance to oxidation at high temperatures, high abrasion resistance, and similar characteristics not generally required in the more common deposits.

Much of this development results from the need for better materials for jet engines and other precise military items, and follows the common metallurgical trend of turning to tailor-made alloys when the desired properties are not obtainable in the purer metals. It is significant that electroplating is thus being utilized more and more as an industrial processing method to solve problems of which the average person is not aware, and where the actual plated surface may never be exposed to visual observation.

Many new and unusual combinations of metals can be produced by electrodeposition, challenging the metallurgist to study their properties and determine their best applications. Eventually this procedure will be reversed, and the plating department will find itself being asked to produce deposits having well defined and reproduceable engineering properties. This is the inescapable path of progress, and will present a challenge to the industry of unprecedented complexity.

We have become accustomed to the necessity for close cooperation between the plater and the chemist, however painful and slow the lesson was learned at times, but we can expect that in the future a third party, the metallurgist, will be eying the plating department with more than the usual disdainful look.

Plating in the Recording Industry

By Marvin Rubinstein, *New York City*

GIVEN impetus by the prosperity of World War II, the phonograph record industry jumped to unprecedented heights of activity. Today there are over two hundred record companies in the field, with assets of over one hundred million dollars. Little known to the average plater is the fact that the heart of each record concern must be a highly specialized but extremely well equipped plating room.

Before continuing, a brief explanation of how records are manufactured would be in order. Phonograph records are pressed on either mechanical or hydraulic presses from a thermoplastic material known as the "biscuit." The actual reproduction of the grooves is taken from metal molds attached to the upper and lower dies in the press. These metal molds, called "stampers," are the end product of the plating room. While the stampers are the product used in making the record, two other shells, the "master" and the "mother," must also be electroformed before a stamper can be obtained.

It will be the purpose of this article to trace the various steps from the original recording to the stamper. Since general practice in the field varies widely, this article will attempt only a resume of the most advanced methods.

Photos not marked otherwise by courtesy of Audio Matrix Labs., Bronx, N. Y.

The Author

Mr. Rubinstein studied chemistry and chemical engineering at Cornell University, then started in the finishing field with the Hickok Manufacturing Company of Rochester, New York. Since then, he has held positions in various phases of electroplating, including production, control, design, research, consultation, and sales. His experience in the phonograph record industry was established when he served as foreman of the matrix department of the Continental Record Company of New York.

Metallizing the Lacquer Disc

The original recording, as received from the studio, is a disc (usually about twelve or thirteen inches in diameter) into which the sound or music lines have been recorded by a diamond shaped cutting needle or "stylus" while the disc rotates on a turntable. The nature of the material being recorded, its tone, intensity, etc. control the vibrations of the stylus and thus the groove that it engraves into the disc. In the past, these discs were made of wax. Today, however, particularly in the United States the wax disc has been replaced by one of aluminum coated with a smooth heavy film of black lacquer. This is commonly known as the "master recording," "lacquer disc" or "acetate."

Our first step is to metalize the grooved surface of the lacquer disc to make it a conductor. The methods used are similar to those in general metalizing practice, except for two details:

1. Strong adhesion between the metal film and the non-conductor is not only unnecessary but also undesirable, as we must later "strip" the lacquer disc from the electroformed metal mold.

2. The cleaning process must be such that absolutely no dirt or grease remains on the lacquer disc. At the same time it must be extremely gentle, for, as the music grooves are very delicate, any harsh treatment will cause a scratchy surface noise in the final record.

Three methods of metalizing are found in use in the industry. The first, brushing on finely divided graphite, was for the most part used on wax recordings. This has fallen into disuse today. High quality records, without surface noise, were difficult to produce by the graphiting method. The second method, that of cathode sputtering with gold or copper, has been used by several firms with great success. Unfortunately, the equipment is expensive and a thoroughly experienced operator is necessary. The third method, most generally used, is the formation of a silver mirror on the lacquer disc by reduction of a silver nitrate solution. This method is simple, quick and effective, and consists of three principal steps.

CLEANING:

Allow the lacquer disc to soak in gasoline or similar solvent for two minutes. Hard rubber or glass trays are excellent for these operations. The grooved sur-

face is then swabbed gently with a wad of cotton wool soaked in gasoline. Only light pressure is needed, and care should be taken to see that the cotton is always wet with gasoline and that no dust or dirt has settled on it. Sharp particles of dust will scratch the lacquer disc. Thoroughly dry the disc on a rapidly (1700 r.p.m.) rotating spindle.

The lacquer disc is then given a one minute dip in a solution of chromic acid (32 oz./gal.), after which it is rinsed with great care to remove all the chromic acid. It is recommended that a very fine high-powered water spray nozzle be used for all rinsing operations and particularly this one.[1] The disc may be hung on a spindle and rotated by the force of the water spray or dipped several times into a spray tank. If all of the chromic acid is not removed, the lacquer disc will later stick to the metal mold and stripping will be difficult or impossible. Finally, the lacquer disc is washed with a solution of the following composition:

Sodium cyanide—8 oz./gal.

Whiting—enough to make a thin paste

An extremely fine and soft camel-hair brush is used in this operation. The paste is brushed onto the lacquer disc, so that the tips of the brush hairs lightly clean the sides of the grooves. Once more the disc is thoroughly rinsed before the next operation. A final distilled water rinse is recommended in regions where the water is hard.

SENSITIZING:

Though this step is not absolutely necessary, a more uniform, more adherent coating of silver is obtained if the disc is sensitized in a stannous chloride solution before silvering. A solution of 2½ grams of stannous chloride per liter of distilled water has proven satisfactory, though any strength from 0.1 to 15% will work. The disc is dipped into this sensitizing solution for thirty seconds. It is then very thoroughly rinsed with tap water and finally with distilled water. Insufficient rinsing will give a mottled appearance to the silver coating and eventually to the record. This is particularly important since lacquer discs occasionally have fine pin holes in their surfaces. The stannous chloride or the sodium cyanide used in cleaning settles in these holes and later reacts with the silver solution leaving smokey, gray spots or crosses with dark black centers. These spots will later show up as "clicks" in the finished record.

SILVERING:

Here again numerous solutions are available, and general silvering practices prove satisfactory. For good results a modified Brashear solution is recommended. This is prepared from the following stock solutions:

Silver nitrate, 400 grams per liter.

Sodium hydroxide, 200 grams per liter.

Ammonium hydroxide, concentrated.

All chemicals are C.P. grade and distilled water is necessary. To prepare the silvering solution, these are mixed in the following order:

Distilled water, 1000 c.c.

Silver nitrate stock solution, 120 c.c.

[1] The Spraying Systems Co., Chicago, Illinois, supplies such nozzles.

Figure 1—Silvered acetate being placed in the nickel tank for initial deposit. Copper flash tanks in background.

Ammonium hydroxide, until solution clears (about 40 c.c.).

Sodium hydroxide solution, 120 c.c.

Ammonium hydroxide, 30 c.c. Continue adding additional ammonium hydroxide drop by drop from a burette until the solution just clears.

Distilled water, 200 c.c.

Both the silver stock solution and the prepared silvering solution are kept in brown bottles in a dark, cool place. While the stock solution can be kept indefinitely, the silvering solution should not be kept over two weeks. It is important to realize that the prepared silvering solution is explosive and very dangerous when allowed to dry or when heated above 150 degrees Fahrenheit. All spillage must promptly be cleaned up. All glassware used must be rinsed promptly, and the solution must be kept away from heat.

An excellent reducing solution can be prepared by dissolving 100 grams of granulated sugar in 1000 c.c. of distilled water. Bring the solution to a boil, add four c.c. of nitric acid, boil for three to five minutes, cool and store. If the solution is not to be used for at least one week, or if dextrose is substituted for granulated sugar, the boiling may be omitted. To prevent mold formation in the solution use 200 c.c. of grain alcohol instead of an equivalent amount of water, or store the solution in a refrigerator. Formaldehyde or any of the several tartrates also make satisfactory reducing agents. The tartrates, however, are not quite as effective. Formaldehyde acts more rapidly than sugar, but has an odor highly objectionable to many people.

The silvering process follows immediately after the sensitizing and rinsing. All of the steps in cleaning, sensitizing, and silvering must be done quickly so that there is no waterbreak from the initial cleaning to the time the lacquer disc is put into the plating bath. Care should also be exercised in handling the disc so that at no time do the fingers touch the surface of the disc, only the edges. Waterbreaks or fingerprints will leave dark smudges on the silver film.

The lacquer disc is placed face up in a clean tray. Three hundred c.c. of prepared silvering solution and 50 c.cfl of sugar reducing solution are mixed in a beaker and quickly poured over the center of the lacquer disc. Now the tray is agitated by slowly tilt-

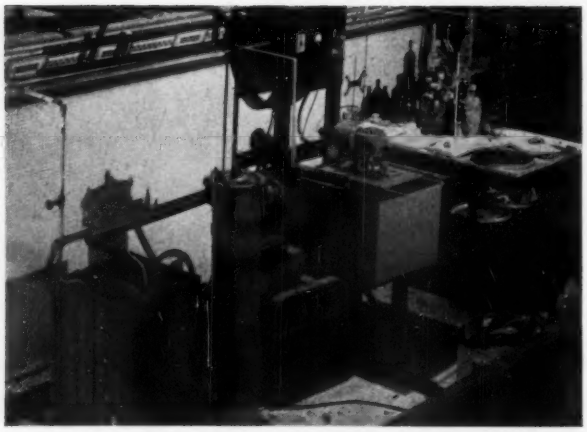


Figure 2—A single high-speed plating unit for the acid copper bath, showing the rotating device, sump tank, and continuous filtration set-up.

ing it back and forth (and from side to side) so that the solution flows over the face of the disc. A uniform film of silver will soon form over the surface. Continue the silvering until the solution is no longer clear and a back precipitate becomes apparent. Pour off the solution, rinse thoroughly, and look over the surface for complete coverage. The disc is then immediately placed in the plating bath. If any delay is necessary, the disc should be left in clean water, but not for over five minutes.

Where the lacquer disc face has not been completely covered, two courses of action are available. It is possible to give the disc an additional film of silver. This is not advised since it often results in surface noises on the record. A better method involves removing the silver film with chromic acid (the cleaning solution concentration given above is satisfactory) and a wad of cotton wool. The cleaning operation is then repeated, except for the gasoline, and the disc resilvered.

Nickel Plating

For our purpose a tough but only moderately hard nickel plate must be obtained to avoid peeling near the center of the disc where the surface tension is unusually high. This is also necessitated by the fact that in later operations we must chrome plate over the nickel. Four solutions are in general use, though the fourth one listed is not recommended for this particular sequence of operations. A Watts type bath, as described in the Metal Finishing Handbook, gives good results. The following three baths can also be run satisfactorily:

1. Double nickel salts	4 oz./gal.
Single nickel salts	16 oz./gal.
Boric acid	3 oz./gal.
Nickel chloride	3 oz./gal.
pH (colorimetric)	5.8—6.0
Temperature	100 Degrees F
2. Single nickel salts	40 oz./gal.
Nickel Chloride	2.5 oz./gal.
Boric acid	2 oz./gal.
pH (colorimetric)	5.6—6.0
Temperature	110 Degrees F.
3. Single nickel salts	8 oz./gal.
Magnesium ammonium sulfate	4 oz./gal.
Ammonium chloride	1 oz./gal.
Boric acid	2 oz./gal.
pH (electrometric)	6.2
Temperature	110 Degrees F.

The silvered lacquer disc is screwed onto a rack at the center hole using a copper washer for good contact, and immediately placed in the nickel bath. Here it is plated for one hour at 5 amperes per square foot. The area of only one side is considered, since the anodes should be so arranged that only the face of the disc is towards them. Rack handles should be tapped every few minutes to remove any accumulated gas bubbles, which would cause pits in the plate with resulting "ticks" or "sand" in the record. This tapping can be avoided if gentle cathode agitation is used after the plate has been in for ten minutes. A thickness of about 0.0002 inch of nickel is plated from the solution.

Copper Flashing

Upon removal from the nickel plate, the acetate is thoroughly rinsed and given a five second dip in a 20% sulfuric acid solution. After rinsing again, it gets a preliminary plate in an acid copper bath under the following conditions:

Copper sulfate	32 oz./gal.
Sulfuric acid	4 oz./gal.
Temperature	Room
Current density	20 amperes/square foot
Time	20-30 minutes
Agitation	Preferable but not necessary

The acetate is now ready for the copper electroforming process and is allowed to dry (on a rack where the face is never touched) until enough plates are ready for a load.

Electroforming

In the next step, a thickness of copper far greater than that usually encountered by the average plater is put on the disc, a thickness of from 0.050 to 0.070 inches.[2] To complicate the problem, this copper must have a smooth surface without lumps or nodules, must be hard and springy without being brittle, and must have a well controlled and constant thickness graduation from the edges to the center. Finally, it is desirable to produce these shells as rapidly as possible. To those who know the problems of plating, this is quite an order.

Strangely enough, about four basically different types of equipment are in use throughout the industry today for this operation. All work satisfactorily, but all take too long—anywhere from six to 48 hours to form a master. The shortest method, which happens also to be the best, involves the use of a rapidly rotating cathode. Diagram I shows the arrangement of equipment for each plating unit. There may be from one to 20 units per tank, but each unit must have at least 75 gallons of solution. About six units is recommended as a compromise between good solution con-

[2] In some shops, the masters are only plated to 0.030 inch and "backed up" with either a sheet of copper or a plastic material similar to the record biscuit. This practice is on the wane.

trol (which is easiest in a larger tank) and the convenience and mobility of a smaller tank.

The solution is circulated continuously between the sump tank and the plating tank at a rate of about 6½ gallons per minute. An overflow is provided at the back of the tank near the top so that the solution may flow to the sump tank by means of gravity. It is pumped back to the plating tank and shot up against the face of the rotating cathode, either from a narrow pipe orifice or, preferably, from a spray nozzle. Great care must be taken to see that no air is pumped into the tank, since any little air bubbles may catch on the face of the plate and cause pits in the copper. Continuous filtration is recommended at the sump tank.

Flat rolled, annealed copper anodes are used. These are held in a bakelite tray below the cathode and should always be maintained at as near a constant level as possible. If the level of the anodes changes, the thickness gradation of the finished shells will vary. By properly controlling the distance from the anode surface to the cathode surface and the position of the "mask" between them, it is possible to get a constant thickness variation of from 0.003 to 0.020 inch from the edge to the center of the shell. A pyramid or cone-shaped arrangement of the anodes has been tried successfully to get a gradation of less than 0.001 inch. This, however, is cumbersome. The exact gradation desired is achieved by varying the distances just mentioned. The purpose in maintaining this thickness control will be discussed later. Such control is much more important in forming the stamper than for either the master or mother. Actually, in making the master, the mask may sometimes be removed. It is necessary to clean the anodes frequently to remove any copper oxide film, which causes polarization.

Anode contact is maintained by a sheet of lead (preferably alloyed with 1% silver) placed under the anodes and connected to the positive bus bar by an insulated strip of lead. Cathode contact is by means of the brushes shown in Diagram II. These brushes should always be kept in good condition to maintain a constant current flow. As a current source a rectifier is preferred, using individual rheostats for each unit (connected in parallel) to maintain proper control. One hundred and fifty amperes at from six to nine volts should be provided for each unit.

Optimum cathode rotation is about 175 r.p.m. The cathode shaft should be insulated from the solution by a suitable stop-off everywhere except where it contacts the shell. A copper shaft is preferable, though stainless steel is satisfactory. Commercial set-ups are available for all the above equipment, or they can be prepared in any shop or tool room using the illustrations given here and a little ingenuity.

The Oxide Copper Bath:

An acid copper solution is needed for electroforming, since cyanide solutions tend to roughness when plated in substantial thicknesses. The following bath and conditions have been found highly satisfactory:

Copper sulfate	32 oz./gal.
Sulfuric acid	8 oz./gal.
Temperature	80-110 Degrees F.
Voltage	6-9 volts
Current density	10-175 amps./square foot

Proper hardness of the copper is maintained through temperature control, control of current density, and by the use of addition agents. Several addition agents have been used successfully, but all require constant vigil. Glue is too difficult to control. It causes brittleness at the least over-concentration. Phenolsulfonic acid in concentrations of about ¼ oz./gal. gives a copper of excellent physical properties. But it is difficult to achieve the required hardness in using it. Furthermore, there is too large a time lapse between the addition and the hardening effect. Probably the material which gives the best compromise between desired results and a minimum of control is molasses. This material, in concentrations of about one pint per 100 gallons gives a smooth, fine-grained springy plate—hard, and with a high tensile strength. It should be dissolved in plenty of solution and distributed throughout the tank when the load is half finished. Fortunately, the concentration is not too critical.

If you will settle for nothing short of a perfect plate and don't mind being a constant nursemaid to the solution in order to get results, you might try a mixture of a 25% sodium cyanide and a casein solution prepared as follows:

Dissolve 25 grams sodium cyanide in 1,000 c.c. of water.

Add 25 grams of *technical* casein. Stir thoroughly.

Let stand 12 hours. Boil 30 minutes.

Cool, filter, bring up to 1,000 c.c.

To add to the bath, add the cyanide solution to 1,000 times its volume of water. Stir thoroughly and add

Figure 3—Loading position for copper tank, showing anodes in the tray, overflow outlet, and matrix with rubber ring in position.

the casein. This mixture is to be poured slowly into the bath at the end of each load, thoroughly distributing it. Three c.c. of casein and two c.c. of cyanide for every fifty gallons of solution are used per load. The shells must be watched carefully, and if any slight sign of scar-like pitting is noticed, the cyanide and casein addition must be discontinued for the next load or two. If your nerves are good, this gives a beautiful plate.

Other factors, of course, affect the hardness and must be controlled. Extraneous organic impurities and decomposition products increase both hardness and brittleness, and must be filtered out with carbon periodically. Lower copper sulfate concentrations and higher acid concentrations increase hardness. Higher current densities tend to give a harder copper. Finally, and most important, even small temperature rises are accompanied by appreciable softening of the copper. With proper handling, a consistent Rockwell F hardness of from 60 to 90 and a tensile strength of from 30,000 to 50,000 p.s.i. can be maintained.

A load of silvered and copper flashed lacquer discs are put into the high-speed acid copper bath. The discs are first fitted with rubber rings, after which they are fastened (face out) to the end of the rotating cathode rod by means of an insulated threaded collar. The rubber ring, which covers the edges and the back of the plate to about two inches in from the edge, serves as protection against treeing. The rotating set-up, acetate and all, is then lowered into the solution. Starting the cathode rotation and the circulation of the solution, the current is built up slowly, as follows:

No current	5 minutes to clean dust off face of plate
20 amps./square foot	10 minutes
50 amps./square foot	10 minutes
75 amps./square foot	10 minutes
100 amps./square foot	10 minutes
150 amps./square foot	until completed

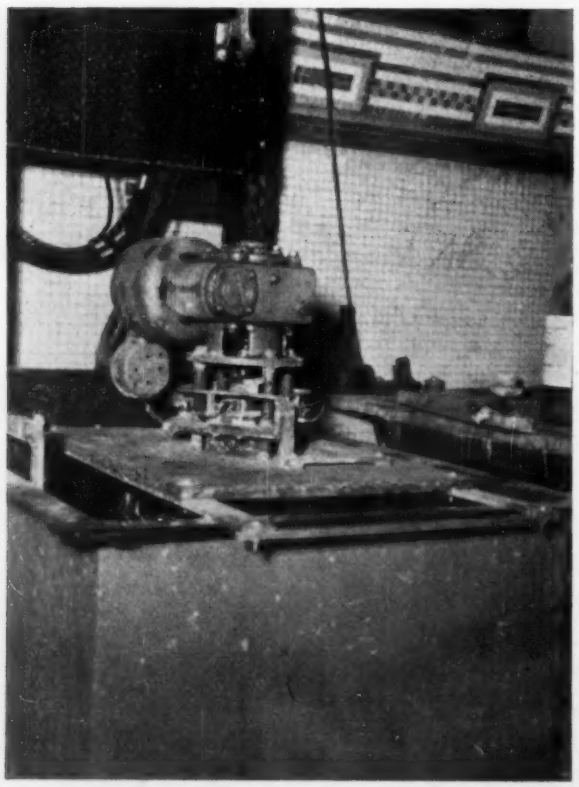


Figure 4—A semi-commercial set-up for rotating the cathode. This is somewhat different from the one described in the text.

Time necessary for completion naturally varies according to the thickness required. About seven hours are needed for a plate of 0.050 inch, a fairly standard thickness for masters. The slow current build-up helps prevent roughness, burning, and breaks near the center of the plate where the tension is highest. It is imperative that the plates be raised from the solution and inspected every half-hour. At such times, all imperfections should be noted, and the more seriously damaged plates removed from the bath. In addition, any changes in conditions must be made then. Care should also be exercised in seeing that the rotation, circulation and current controls are all in good working order. As a matter of fact, the two words "cleanliness" and "control" are the key to successful record matrix plating. Hardness and tensile strength tests should be made at the end of each load.

The Metal Master

Upon removal of the load from the acid copper bath, alternate rinsing in hot and cold water, and drying, the discs are ready for the stripping operation. This involves removing the rubber ring, lightly running over the edges with a moderately fine file, and manipulating the plated disc in the hands until the lacquer disc separates from the electroformed metal mold. To do this, the disc is taken in both hands, with the plate facing the operator. With four fingers of each hand holding the disc firmly at the edges, and with both thumbs near the center, the disc is gently flexed up and back (meanwhile rotating the disc) until the weak bond at the silver-lacquer interface parts. The resulting two sections are the original lacquer disc and an electroformed negative of the lacquer disc, the metal master.

The used lacquer disc is now filed away in case it should be needed again. The metal master, still in the rough, must undergo several finishing operations. Since in most cases the central washer falls off during the stripping operation, a small octagon shaped piece of copper sheet is soldered over the irregular opening now left at the center. Scrap matrices make a good source for the copper sheet used. The next step involves a centering and punching operation. By "centering" is meant finding the musical center of the record, that is to say, the center point from which the needle will swing an equal amount in all directions when the record is played. This prevents the needle from pushing too hard against one side of the groove with ensuing distortion in the music. To achieve this, the master is placed on a specially constructed combination turntable and punch. A pick-up arm using a fiber or cactus needle is lowered on the master so that the needle rests in the grooves near the center. The turntable is then revolved slowly by hand, while the other end pushes against a dial indicator, recording the deflection from center. By alternately easing the master in the opposite direction from the major deflection and rechecking the scale readings, the point

is reached where the needle deflections do not exceed 0.002 to 0.003 inches on the dial. This being the musical center, the center punch is now brought down. This gives a hole 0.285 inches in diameter (that of the spindle in most modern phonographs).

The hole is now fitted over the spindle of a circular trimming machine, previously adjusted to a desired size, and the master is trimmed to this size, usually about one inch less in diameter than the original acetate. Edges are then smoothed on a grinder using a 280 grit abrasive belt. Another step often used at this point is to stamp identification numbers into the master at a point near the center. For this purpose a set of steel stamping initials and letters and a wooden mallet is used. The silver film must now be removed, most of which is retained on the metal master. This can be done by several means, including electrocleaning, polishing, or washing off with a cotton wool swathe, soaked in a chromic acid solution. Washing the master with a cyanide solution and a soft brush to remove any stains from the soldering flux follows. Then, a final polish with a brush and gasoline on a rotating spindle, and the master is completed. Rouge, levigated alumina, or any of several proprietary polishing compounds are sometimes used, but overpolishing should be avoided. Finally the master is inspected with extreme care, any flaws noted, and processed for the next step.

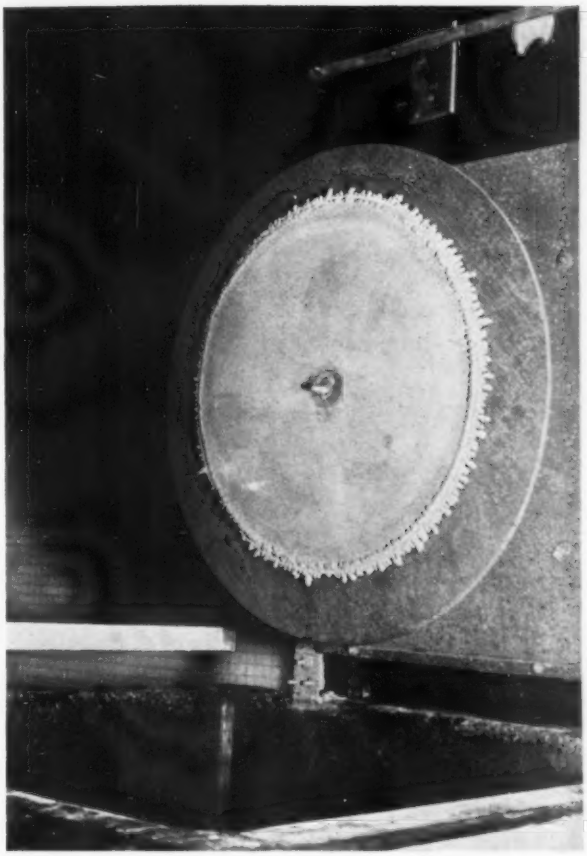
Processing

Processing is preparing the master for electroforming the mother (or the mother for the stamper). The master is removed from its storage envelope and inspected. It is then thoroughly scrubbed with the same cyanide-whiting solution used on the lacquer disc, using an oval, shoebrush type brush with moderately fine bristles. Thorough rinsing, preferably with a fine water spray, follows; the cleaning and rinsing process is repeated. The master is then gone over with a brush dipped in a solution prepared as follows:

Silver nitrate	3 oz./gal.
Sodium chloride	1½ oz./gal.
Potassium cyanide	6 oz./gal.

Distilled water is used. The purpose of this operation is to make certain that no copper spots are exposed due to defects or thin spots in the nickel. Such spots would later cause sticking; this silvering process avoids this by forming a thin displacement film of silver on any exposed copper. After a final rinsing using a clean brush and distilled water, the master is racked and dipped in the separator solution for five to ten seconds. Here, timing is extremely important since too short a period in the separator will later cause sticking, while too long a dip will often cause the master and the mother to separate or partially separate in the acid copper with resulting stained nickel from the sulfuric acid. Though potassium iodide and other type separators also find use,[3] the following preparation is recommended: Add enough potassium dichromate to distilled water to bring the hydrometer reading to one degree Baumé. Where hard water is used, add a small amount (about two grams per gallon) of borax. From the separator the processed master goes directly into the nickel bath.

[3] A process for forming a separator film by electrocleaning has been developed recently.



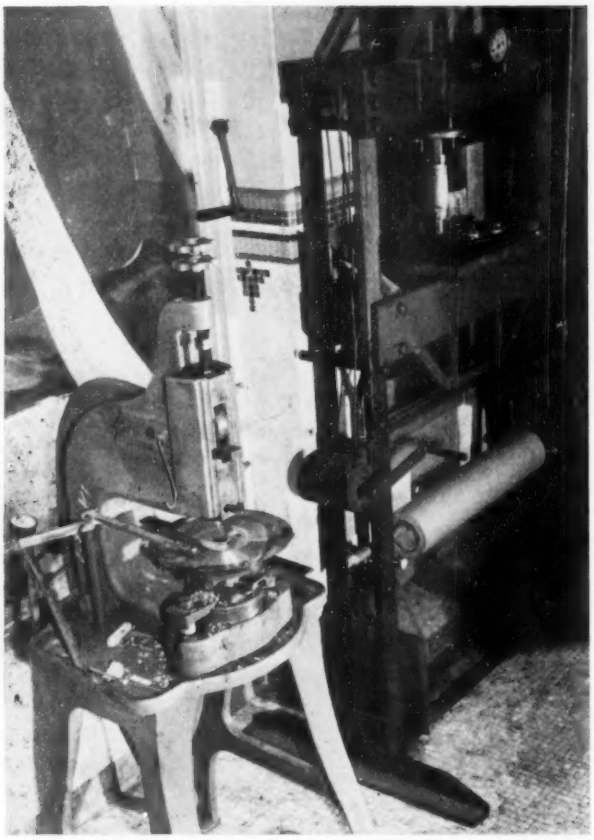
(Photo courtesy Audio Engineering Magazine)

Figure 5—Plated matrix shown attached to the bottom of the rotor, when rotating device is raised. Note the edge effect encountered when the rubber ring is not put into place around the rim to prevent "treeing".

In placing the master in the nickel solution, we must be certain that immediate electrical contact is made, otherwise the nickel solution will eat up the separator film. The purpose of this very thin film is to provide a conductive but non-adhesive surface between the two nickel plates. Therefore, if the film is eaten away, sticking and difficult stripping would later develop. To insure immediate contact, a flexible cable from the cathode bar to the rack holding the master is often used. Using the same nickel solution as that for plating the acetate, the time and amperage are varied somewhat. The processed master is plated for ½ hour at 6 amperes per square foot and then upped to 10 amperes per square foot for 1½ additional hours. Every fifteen minutes, the plate is given a 180 degree turn on the rack. This gives a nickel plate of 0.001 inch. Following the two hour nickel plate, the master is rinsed, given a 20% sulfuric acid dip and rinsed again. Now the processed master is given a ½ hour copper flash at 24 amperes per square foot, and the electroforming process in the high speed acid copper is repeated, using the same directions as previously described.

The Mother

The procedure for completing the "mother" is similar to that practiced on the metal master. After removing the mold from the acid bath, it is rinsed carefully and stripped as previously described. In this



(Photo courtesy Audio Engineering Magazine)

Figure 6—Centering machine and center punch. In rear is a hydraulic press for punching out the center disc on the finished stamper.

case, however, a grinder with a #60 grit abrasive belt may have to be used to separate the edges before flexing the plates. In any case, after separation, there are two plates, one the original metal master, which is cleaned and stored away in a cardboard envelope, and the other a reverse mold whose grooves are identical with those of the original acetate. The "mother," as this plate is known, instead of being lacquer coated aluminum, consists of a copper plate with a thin film of nickel on the surface.

Then follows the usual finishing procedure. Soldering, centering and center punching, picking off nodules, edge smoothing, and the usual cleaning and polishing methods are used, with three exceptions: it is not necessary to remove any silver film here since none exists; identification numbers have been reproduced from the master, so the stamping procedure may be avoided; trimming to size is superfluous, since both master and mother should be approximately the same size. Finally, in many firms the "mother" is given one additional treatment: it is actually played on a phonograph using a cactus or fibre needle. Any "ticks" or other imperfections are noted, and whenever possible corrected by a craftsman using fine engraving needles to smooth out the grooves where required. Like the metal master, the "mother" is then processed and sent through the nickel and acid copper to form a stamper. Here the procedure is identical to that previously described for making the "mother."

The Stamper

The final product, the stamper, requires great care and rigorous production control for proper results. The production steps to be followed are three in number, though not always in the order given. Step number one involves removal from the high speed acid copper bath, rinsing, stripping, soldering and centering, and the usual polishing and preliminary grinding. The second step is chrome plating the stamper. In the final step is established the proper thickness and inside and outside diameters. Since all of the preliminary finishing steps on the stamper are similar, if not identical, to those used for both the master and the mother, they will not be re-described.

CHROME PLATING:

There was a time when the stamper was put to work with only a nickel face. Not too long ago, it was discovered that a thin film of chromium, about 0.0001 inch thick, easily doubles or triples the life of the stamper. This is due partially to the extra hardness imparted, but probably mostly to the low frictional coefficient of chrome which allows the biscuit to slide over the face so much more easily while pressing the record. In any case, all firms now chrome plate their stampers.

The conventional type bath finds use with most firms, though some are now changing to the more dilute (33 oz./gal.) bath. This naturally involves the use of a higher voltage. Normal conditions for the conventional bath are as follows:

Chromic acid	53 oz./gal.
Sulfate (as sulfuric acid)	0.53 oz./gal.
Temperature	105—120 degrees F.
Current density	110—130 amperes/square foot
Voltage	6—9 volts
Anodes	antimony-tellurium-lead preferred
Time	10—15 minutes

Figure 7—Fastening stamper to heavy metal rack prior to chrome plating.

Figure 8—Testing a finished record for undesirable surface noises caused by defective plating.

Temperature and current density variations are allowed to give the operator more control over the quality and brightness of the plate, since these will vary somewhat as the bath ages. If the plate appears "milky," raising the current and/or lowering the temperature will often correct it. A "matte" or dull plate can usually be corrected by heating the solution and/or lowering the current. Burning, of course, is caused by too high a current for given conditions. Very little trouble should be encountered if the solution is kept up to par, the proper conditions maintained, and all electrical connections kept clean. It is a good idea to correct or "rectify" the trivalent chromium content every so often with a porous pot.

Before chroming, the nickel face of the stamper must be thoroughly cleaned and polished. During the interval between polishing and chrome plating, nothing must touch the face of the plate. Any smudge of fingerprints would show up after the chrome plating. Thus, all handling should be done at the edges and center, preferably with gloves. Electrocleaning after polishing or a few seconds of reverse current cleaning in the chromic acid bath are optional. Where the stamper has been allowed to lie around a long time before chroming, it may be necessary to activate the nickel face. Twenty seconds in the following bath will accomplish this:

Sodium cyanide	10 oz./gal.
Double nickel salts	¼ oz./gal.

Reverse current at 6 volts.

This step, however is best avoided by chroming as soon as possible. For best contact and results, the plate is usually fastened to a rack made of a round piece of ⅛ inch thick copper. The rack is about 12 inches in diameter, has a heavy copper handle welded to it, and a threaded pin at the center. The stamper is fastened face out by an insulated nut at the center of the rack. Closest contact is naturally at the center, but there is also contact all over the rack. By having the center screw extend on both sides, two plates per rack can be accommodated. The anodes are arranged accordingly. It is important during the plating to maintain good contact. It is equally important after removal from the bath to rinse thoroughly several times. Chromic acid drying on the plate shows stains difficult to remove and will later cause sticking when pressing the records. As an extra precaution after rinsing, the plates are washed with a brush and a solution of non-rosin base soap. They are then rinsed once more and polished on the spindle. Where stains, burning, a matte finish, milkiness, or any other faults are noted in inspection, the plate must be re-chromed. This is accomplished by stripping the defective plate in a 50% hydrochloric acid solution, rinsing, re-polishing, and re-plating.

Dimensioning

As previously noted, the finished stamper is to be fastened to the dies of a record press. These dies are alternately heated and cooled by steam or cold water passing through internal channels. In some cases, the dies are flat. In others, there is a 0.010 inch gradation from the center to the outer edge to provide better flow. The stampers are fastened to the dies by means of two rings, one clamped down on the outer rim, and one clamped or screwed down near the center. All of these factors must be provided for in the finished stamper. Firms using graded dies usually provide for this by so adjusting the anode and cathode positions

Figure 9—The completed matrix is placed in a protective envelope and filed away.

with regard to the mask and to each other. Proper design and care gives a constant variation of 0.010" plus or minus 0.0015". This has been covered earlier in the article. Where flat dies are used, the backs of the stampers must be cut down on a lathe. To achieve this, the stamper is held in position face down and slowly revolved on a vacuum type chuck, while the bit takes off any excess copper. A speed of about 200 r.p.m. and a vacuum of from 15 to 25 inches is satisfactory. Two or three cuts are usually taken, beginning with a coarse cut and tapering down to successively finer cuts. Both the flat and graded stampers have their backs finished off on a spindle using successively finer grits of sandpaper and a light oil on the final sanding. It is vital to achieve an extremely smooth back since any irregularities or protrusions will "break through" and show at the front of the stamper due to the high pressures used in stamping the record.

Inside and outside diameters are also important. Due to the frequent heat expansion and contraction of the stamper in the press, only a small tolerance is allowable. On O.D. tolerance of from plus 0.0005 to minus 0.002 inches is maximum. A larger stamper is apt to bulge on expansion. A smaller one may slip through the ring.

Similarly the I.D. should have a tolerance of plus 0.002 inch and minus 0.0005 inch. To check these, a machined ring of the proper size is kept at hand. To cut the plate to just above proper size, a circular cutting machine is used. It is then either ground down to size or trimmed down in a lathe. The inside circle is usually cut out with a die using a foot or hydraulic press. A few firms today are using a large die to cut both the outside and inside diameters simultaneously, thereby eliminating a lot of fuss and bother. Such a die is, of course, expensive. All the dimensional preparations completed, the stamper is given a final polish on the spindle, and carefully inspected.

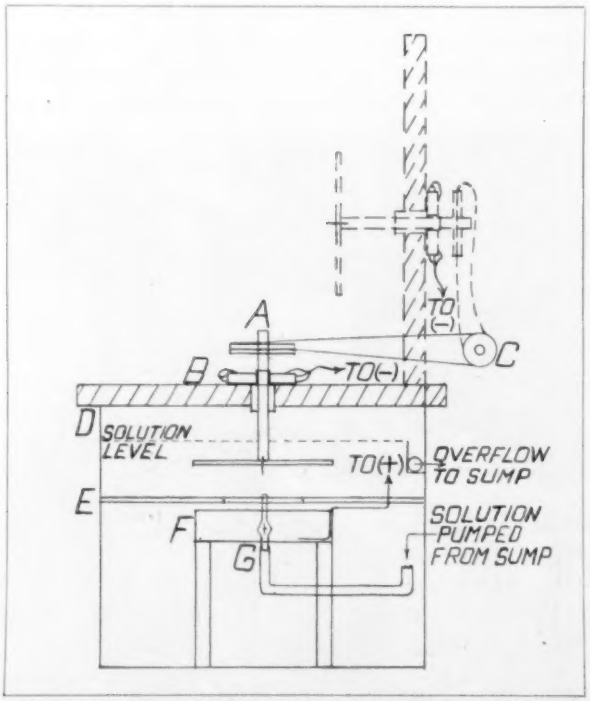


Diagram I. Schematic diagram of a single high-speed plating unit, shown in both working and in loading (broken lines) positions. "A" indicates shaft assembly; "B" carbon brushes and brush holders; "C" drive shaft, belt, and pulley assembly; "D" wooden support for rotating mechanism; "E" baffle or mask; "F" bakelite tray filled with anodes, and "G" a spray nozzle. Heating and cooling coils are not shown. The drive shaft and pulley assembly may be replaced with a single ⅓ h.p. motor, as in Fig. 4.

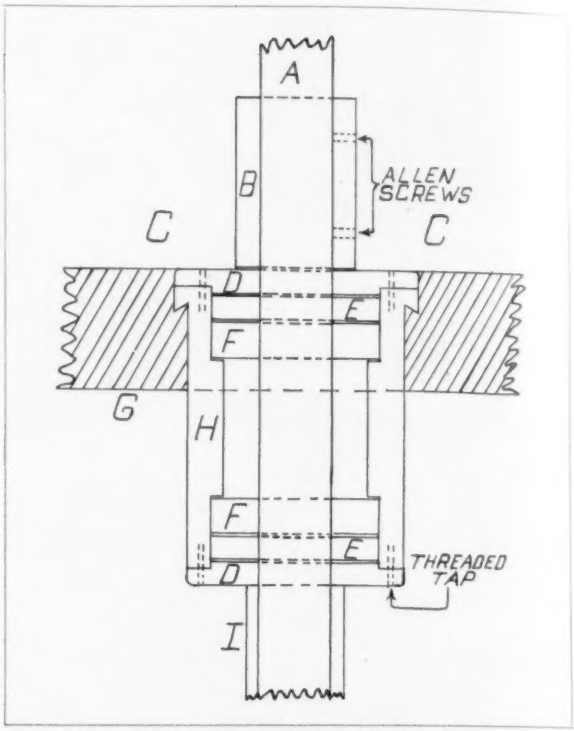


Diagram II. Cross sectional detail of a simply machined bearing housing set up to hold rotating shaft. "A" shows shaft; "B" brass coupling for good cathode contact; "C" position of brush holders which are screwed to wood (preferably cypress) support "G" and which presses brushes against rotating coupling; "D" indicates packing gland; "E" acid resistant packing; "F" sealed bearing; "H" bearing housing, and "I" shaft insulation. The packing glands, housing, and shaft insulation are made of an acid resistant material similar to laminated bakelite.

Summary

As can be seen, the process for the manufacture of phonograph record matrices is both complex and specialized. Nominally, it is of little use to the average electroplater. We should not, however, forget the fact that the field of electroforming becomes more important every day. It is in the rapidly advancing matrix plating room where everything must be "just so" that many of the original principles and advances in electroforming have been and are being made. It is here that constant filtration first came into everyday use. It is here that the best has been gotten out of the acid copper bath and that much of the work on addition agents for hardening has been done. It is here that experiments with high concentration, high temperature baths and with fluoborate solutions are taking place. In the record industry today we find experiments going on with high speed agitation, periodic reverse current, and the use of insoluble anodes with the anodes being dissolved by the porous pot method in another tank. The plater who would keep up with all the advances in his field as they are being made would do well to keep his eyes on plating in the phonograph record industry.

The Relation of Finishing to Design, Materials and Processing Methods

By **Edward Engel**, *Consulting Engineer, Colonial Alloys Company, Phila., Pa.*

Introduction

THE present article discusses the need for greater coordination of the design, engineering, and production departments with the finishing department. The emphasis is on surface finishing and its relation to the other factors in the production of metal articles. These discussions indicate why surface finishing should be given more than merely a final consideration. Experience has shown that form and function are not seen apart from finish. Appearances, superficial or otherwise, are at all times vital. Although the stability of the finish may not always add to the functional life of a product, it is certain that "pride-of-ownership" vanishes when the appearance is lost. Therefore, the finishing aspect of a product should be given equal and simultaneous consideration with its design, functional and production factors.

Materials

All metals and alloys do not respond the same or equally well to plating, anodizing and dye-coloring processes. Metals and alloys also vary as to their properties in machining, drawing, forming and joining operations. Their relative availability in various sizes and mill-shapes is another factor which may restrict choices. It is apparent that the design, metallurgical, production, and finishing departments require each other's counsel at the inception of a new product.

It has been said that a skyscraper is half finished by the time it reaches street level. Similarly, it may be claimed the surface finishing of a metal is nearly completed before it is started, *if* a proper foundation is provided. The correct alloys and surface conditions constitute the required foundations for appealing and stable finishes.

The choice of a metal should embody consideration of certain interlocking factors, as follows:

(1) Comparative prices of metals and alloys.

(2) The product-designs and assemblies which may permit proper surface finishing.

(3) Functional requirements of the product which necessitate certain mechanical and physical properties in the metal or alloy used.

(4) Comparative workabilities of metals and alloys.

(5) Mill forms and shapes.

(6) Surface condition requirements.

Prices

The price comparisons listed in Table I are for equal *volumes* of metals and alloys as well as on the conventional per pound basis.

Product Design and Assembly

The design of a product and its manner of assembly are factors effecting the selection of a metal finish. The inherent restrictions in polishing, plating, anodizing, and lacquering operations which should be considered in the design and assembly of a product are as follows:

(1) Sharp bends and deep recesses should be eliminated if the part is to be mechanically polished or buffed, plated, or lacquered. Deep recesses are difficult to mechanically polish and buff or plate. Plated deposits and lacquers have less adherence on sharp bends or edges. Chromium electrolytes especially have relatively poor throwing power or coverage in recesses or hidden areas. Lacquers are apt to build up in such areas.

Aluminum parts are permitted to have deeper re-

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TABLE I

PRICE COMPARISONS OF COMMON METALS

Metals or Alloys	*Base Price per lb. 0.188" thick Sheet*	**Price-Ratios*	
		Equal volume basis	*Per lb. basis*
Cold Rolled Steel	3.5 cts.	1 (Unity)	1 (Unity)
Aluminum Alloys	24-34 "	2.4—2.7	7.1—7.3
Copper & Brasses	30-34 "	9.1—9.4	9.2—9.5
Monel	43-44 "	12.5	12.6
20% Nickel-Silver	40-44 "	12	12.1
No. 302 Stainless Steel	26 "	7.5—7.8	7.6—7.9
No. 304—20% Clad	22 "	6.3	6.3
Aluminized Steel	9 "	2.6	2.6
Galvanized Steel	4 "	1.1	1.1
Screw Machine Rod Steel (⅜" to 3" dia.)	4 "	1 (Unity)	1 (Unity)
Rod Brass (⅜" to 3" dia.)	25 "	6	6.1
Rod Aluminum (⅜" to 3" dia.)	28-33 "	2.4—2.7	7.8

*Price-Ratios will vary but slightly from those listed (for 0.188" thick sheet or for ⅜" to 3" dia. rod) for other thicknesses of sheet, strip, coil, bar rod, etc.

cesses, as are stainless steel, if they are to be electropolished or chemically polished. Electropolishing and chemical polishing more readily brightens recessed areas than mechanical polishing or buffing. The anodic processes for surface finish stabilization and dye-colored finishes have better throwing power than plating baths. The anodic finish, unlike plated deposits, tends to maintain its adherence on sharp edges, as the film formed by anodic treatments is integral with the basis metal.

(2) The designer should avoid reverse cavities or a multiplicity of cavities, or any construction which may cause difficulties in rinsing and draining. Parts which present the above difficulties slow up production finishing and increase the number of rejects; higher costs and less satisfactory finishes may result.

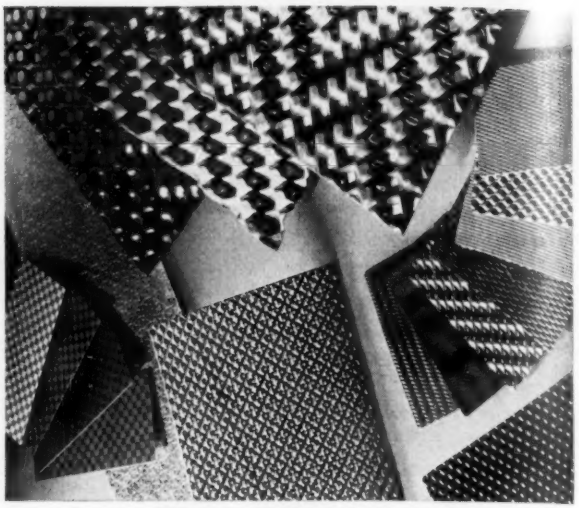
(3) An expanse of plane or flat area, besides being visually monotonous, is too "over-powering" with a lustrous finish. Dirt and finger-prints are obvious on an unrelieved plane surface. Also variations in polishing or buffing wheel pressures and uneven plating or anodizing current distribution, both of which occur on large areas, will be evidenced on expanses of plane surfaces.

Plane surfaces may be given interesting and luxurious appearances by means of three-dimensional surface designs. Marks and smears are less obvious on such surface designs than on unrelieved plane surfaces. (See Figure I.)

In addition to breaking up an otherwise plane surface by means of a three-dimensional design, other approaches are as follows:

(a) Curvatures are ideal for many product designs.

(b) In lieu of curves, the continuity of a plane surface may be broken-up into peaks. The latter are centered between corner radii.



(*Photo courtesy Rigid-Tex Corp.*)

Figure 1—Examples of three dimensional surface finishes available in sheet metals.

(c) Part of a plane surface may be given contrasting effects by means of chemical etching, wire or scratch brushing, ball-peening, sand-blasting or hand-hammered effects, etc.

(4) Parts to be polished, buffed, cleaned, plated, anodized or lacquered usually require "jigging" or racking-up. A major part of the cost in finishing operations is the manual handling in racking-up and in unracking. Therefore, suitable holes or areas should be designed for rack attachment purposes. Otherwise, costs are increased and rack clamp marks may detract from the finish.

(5) In reference to the above, racking-up in threaded holes may injure the threads, and increased care is necessary, hence costs are higher.

(6) The tolerances to be allowed for finishing should be specified. Polishing changes accurate dimensions, and plating adds to the dimensions, which are governed by the thicknesses of the deposits. Anodizing, practically speaking, does not change the dimensions, and may even be regulated to maintain a No. 3 fit.

(7) If any area of a part to be finished requires extra attention it should be carefully designated. Conversely, areas which are hidden after permanent assembly, also should be designated, as many minutes of labor may be saved by not finishing these areas.

(8) A pressed-fit assembly may present entrapment areas for rinse, plating, anodizing and dye solutions, etc. Therefore, such assemblies may engender rejects, as well as increased finishing costs.

(9) Inserts are in the same category as pressed-fits. Anodizing of aluminum die castings, etc., with non-aluminum inserts can only be accomplished by "masking-out" the inserts. The latter operation is expensive and it also results in a higher percentage of rejects. Inserts of different metals, dependent on the metals, may also cause plating difficulties.

(10) Areas to be masked-out should be properly designated. Masking-out involves much higher costs than plating or anodizing. A greater number of re-

jects occur due to the possible penetration or lifting of the masking lacquer, therefore it should only be resorted to when necessary for functional purposes.

(11) Riveted assemblies require more care in cleaning, pickling, rinsing, plating, anodizing and dye-coloring operations. In anodizing aluminum riveted assemblies, the rivets must be of a comparable alloy to the assembly. The above also applies to rivets used to assemble anodized parts. Otherwise, the finish or color will not match.

(12) Soldered and brazed metals offer more difficulty in plating than welded assemblies; some soldered joints may be disintegrated in anodizing baths.

(13) Welded assemblies offer little difficulty in plating baths. Welded aluminum assemblies respond to anodic treatment, although in dye-coloring extreme care must be taken.

The two last named design factors require greater detailing than mere categorical mention. Therefore, these methods of assembly will be discussed in more than a general fashion as to their effects on surface appearance and the difficulties or restrictions caused in finishing operations.

Welded, Brazed, or Soldered Assemblies

(1) Metals to be welded, brazed and soldered must be held together during such operations. Much of the success in joining methods is dependent on proper clamping devices. In addition to supplying neither too little nor too much pressure, the clamp should be arranged so as not to mar the surface of the metals being joined.

(2) Splatter from the joining-metal, or run overs of fluxes may create surface defects. In order to prepare the metal so the splatter may be removed readily, paint the areas adjacent to the weld with a suitable compound or ordinary white-wash.

(3) Aluminum arc-welding rods are usually pure aluminum or a 5 percent silicon-containing alloy. The silicon-aluminum rod welds easier, but the finished appearance of the anodized weld is poor compared to that obtained with straight aluminum rod.

(4) Arc welding of aluminum sheets thicker than No. 12 gauge produces porosity. Therefore, such welds are difficult to plate, and they anodize with poor appearances. Cold hammering of the welds minimizes porosity.

(5) Low carbon columbian-content stainless steel welding rods are required to stabilize the weld on stainless steels against atmospheric corrosion and intergranular corrosion.

(6) It is necessary to passivate stainless steels after welding. Nitric acid passivates these alloys by removing any iron particles attached to their surfaces.

(7) Aluminum may be soldered. The flux usually contains alkali halides, or halides of alkaline earths, or heavy metal halides. Such a flux is very corrosive, so it must be quickly removed to prevent pitting. Soldered aluminum cannot be anodized and there are plating difficulties.

(8) The brazing and soldering of copper and its alloys is very common. Such assemblies need some added care in plating operations. Heat of polishing and grinding may melt low M.P. solders.

(9) Brazed and soldered steels are plateable, but extra care is required.

TABLE II

MECHANICAL PROPERTIES EFFECTING WORKABILITY AND FUNCTIONABILITY

Alloy or Metal	*In thousands p.s.i.*			*Brinell Hardness Number*	*Per cent Elongation in 2-in.*	*Plating or Anodizing Ability*
	Tensile Strength	*Shear Strength*	*Endurance Limit*			
Aluminum 2S	13-24	9.5-13	5-8.5	23-44	5-35	Excellent
Aluminum 3S	16-29	11-16	6-10	28-55	4-30	E
Aluminum 52S	29-41	18-24	17-20.5	45-85	7-25	E
Aluminum 53ST & R-353	39	24	11	80	12-22-25	E
Aluminum 61ST & R-361	45	30	12.5	95	12-22	Very Good
Aluminum 11ST & R-317	49	30	12.5	100	14	VG
Aluminum 17ST	60	36	15	100	18	VG
Aluminum 24ST	65	40	18	105-116	20	VG
Aluminum 75ST & R-303	88	47	22.5	140-145	10	VG
Aluminum Forgings	40-55	30-47	10.5-16	85-100	10-16	VG
Brass—Red	80-85	...	15	40-60	4-43	E
Brass—High	46-92	...	13-17	35-46	15-35	E
Brass—Low	67	...	15	40-60	3-40	VG
Brass-Free Cutting	62-90	...	17	40-60	20-60	E
Copper	32-40	...	17	35-80	20-40	VG
Magnesium-Wrought	32-51	17-23	8-18	40-69	6-19	F-G
Magnesium Forgings	33-45	16-22	10.5-18	43-69	6-19	Poor
Monel Sheet	65-85	20-30	36-52	125-140	25-45	
Stainless Steel Sheet	80-150	...	35-94	130-175	55-65	Fair
Commercial Steel	67-65	...	58-101	135-185	17	E
SAE 1113-Steel Screw Stock	88-105	65		170	15-25	VG

The Functional Requirements

Consideration of the finishing aspect entails the study of the functional requirements of the part itself plus the functional requirements of the finish.

Table II presents the mechanical and physical properties of the more commonly used metals which must be considered in arriving at a suitable design.

The Comparative Workabilities

After a selection is made as a result of the foregoing comparisons, a compromise or alternate choice may be made necessary by the restrictions as to the workability of the metal.

MACHINING:

The most machinable metal is the one which permits the fastest removal of material, but the final surface smoothness must be considered as well. In this respect, published "machinability ratings," which are determined by the speed of stock removal, do not tell the full story for most economical finishing of the machined surfaces produced.

DRAWING & STAMPING:

Important details in forming metals preparatory to surface finishing sequences are, (1) a smooth surface (2) and burrless edges. The correct die design, proper stock and a suitable lubricant will tend to produce the required results.

Drawing and stamping dies should not be completed until dimensional gains or losses, which may occur in finishing operations, are considered.

Drawing tools or dies must be kept well polished. The dies should be polished in the direction of the draw operation, and all serrations on the dies must be removed. It is to be noted that tools which produce the brightest and smoothest finishes are preferred when the work is to be clear lacquered, plated or anodized. Tungsten carbide prevents defects more completely than other die materials for many operations. This die stock also enables the taking of heavier drafts. Carbide dies must be centered more exactly in order to protect them and to produce smooth surfaces. Occasionally, chrome-plated carbon steel drawing dies are used to produce smooth surfaces.

It is also important in drawing operations to prevent any "stretcher strains," as such strains cannot be polished-out. The aim is to obtain fine surfaces with no pits or surface defects whatever.

In drawing aluminum and brass, thorough cleaning must proceed each anneal. Otherwise, the oils may be burned into the metal surfaces causing defects that are impossible to polish-out.

Whenever possible the work should be fabricated, formed or machined, etc., in a manner which tends to eliminate the need of mechanical polishing and buffing, or at least to reduce the degree of such processing.

Rolled threads are more easily plated and anodized than cut-threads. They are stronger and smoother than cut-threads, according to most authorities.

In aluminum, rolled threads when anodized present a non-galling surface.

METAL REMOVAL OTHER THAN MACHINING:

The product designer should consider the advantages of grinding versus machining. Of course, grinding removes less stock than machining, but, when the three design principles listed below are followed, the stock removal limitation is circumvented, so that in many instances the grinding wheel can become a formidable competitor to the conventional cutting tools:

(1) The depth of material to be removed by grinding must be kept to a minimum.

(2) The areas of plane surfaces that are to be ground must be kept as small as possible.

(3) Surfaces to be finished must be made readily accessible to one of the standard shapes of grinding wheels.

It is often necessary to leave excess material on castings to enable the cutter to go deep enough to get under the scale at the first cut. In contradistinction, grinding wheels cut thru hard scale easily. Grinding wheels require 1/16″ or less of excess stock for adequate surfacing, while machining requires 3 to 4 times as much material. Thus:

(1) Less material is wasted.

(2) Less warpage occurs.

(3) A smoother finish can be produced.

The material savings alone, especially on aluminum and copper and their alloys, may pay for the grinding wheel operations

Centerless grinding of tubing, rods, etc., may be fully automatic, and requires less skill than machining operations. Dimensions can be held to 0.0001″-0.00025″. Therefore, for some purposes, centerless grinding may eliminate machining, polishing and buffing operations.

Fine centerless ground (about 500 grit) aluminum tubing can be chemically polished to present a stable, lustrous decorative surface after anodizing.

In addition, surfaces which have been finely ground present better surface conditions than machined areas for mechanical polishing, burnishing and buffing.

SMOOTH METAL REMOVAL:

Some types of cutting-tools produce as smooth a surface as fine grinding, e. g., diamond cutting, reaming and burnish broaching tools. The diamond turning operation on aluminum 17-ST and 11-ST3 creates a 16 microinch surface. The shive turning tool also creates precision surfaces on bar stock in automatic screw machines and lathes. Chrome plated tools produce 50 microinch surfaces.

A smooth surface, whether obtained by machining, grinding, or polishing or any combination thereof, is not "optional." Precision surfaces are "musts" if stable finishes are to be obtained, and, often as not, they cost less in the final accounting.

Forms Available

In addition to the factors listed in the foregoing pages, the available Mill Forms may have merits or restrictions requiring comparisons.

TABLE III

COMPARISONS BETWEEN FORGINGS—DIE CASTINGS-PERMANENT MOLDINGS

Factors	Die Castings			Permanent Moldings		Forgings	
	Aluminum	*Brass*	*Zinc*	*Aluminum*	*Brass*	*Aluminum*	*Brass*
Response to Electrolytic Polishing	Poor	Poor	Poor	Poor to Fair	—	Good	Fair
Response to Anodizing & Die Coloring	Poor-Fair	—	Poor	Poor to Fair	—	Good	—
Plateability	Fair-Good	Good	Good	Fair-Good	Good	Good	Good
Machinability & Tool Life	Poor	Good	Fair	Fair-Good	Good	Good	Good
Surface Porosity—(Comparative)	(2)	(2)	(2)	(3)	(3)	(1) best	(1) best
Blow Holes	(3)	(3)	(3)	(2)	(2)	(1) best	(1) best

Aluminum Die Castings:

These are generally of two types of alloys, e.g., the silicon or copper content alloys. The silicon type, dependent on silicon content, are more easily cast but more difficult to machine and they respond indifferently to anodizing. The copper content alloys are more easily machined and anodically finished with somewhat better results. The magnesium-bearing aluminum die castings are too difficult to cast as far as most die casters are concerned, though they receive the best anodized appearance.

The surface of the die casting in contact with the mold is apt to cool too rapidly. The chilled areas may cause strain-like effects, referred to as "cold-shut" areas. It may be impractical to attempt to polish-out such effects, which usually are quite deep.

It is important to select the proper mold lubricant when die casting aluminum which is to be subsequently anodized. High heat resisting lubricants are available. Lubricants which become burnt into the castings result in poor anodizing and high finishing costs.

The selection of the correct aluminum alloy, the casting procedures, buffing methods and anodizing treatments require considerable experience and study.

Permanent Mold Castings:

These have a better color but more porosity and less surface smoothness than die castings.

Aluminum alloys Nos. 122 and 142 (QQ-A-696a) have low silicon content, so they present fair surface conditions for anodic finishing.

Sand Castings:

These are offered in practically all metals. As a rule, sand castings are poor subjects for plating or anodizing, requiring much preliminary surface preparation. If an assembly of an aluminum sand casting and a common wrought aluminum alloy is to have a uniform appearance after anodizing, the cast alloy should be No. 214 or similar.

Extruded Shapes:

Should be as smooth as possible and the best results are only obtained by frequent changes of dies. The use of extrusions can reduce machining and polishing costs.

Impact extrusions are very economical in certain shapes and cross sectional thicknesses. Very smooth surfaces result if smooth dies are operated.

Forgings:

These are much stronger than castings and are in a better condition with less porosity and practically no blow-holes, as compared to castings. Within their shape limitations, aluminum forgings (except 32-S) are a better choice than die castings if a pleasing anodic finish is required.

Hot-heading, in general, costs more than cold heading. The latter also offers the added advantage of presenting a better surface condition for plating or anodizing.

See Table III for comparisons between Forgings, Die Castings and Permanent Mouldings, as regards finishing.

Surface Conditions

General:

Although a bright surface is desired for many decorative finishes, it is not sufficient in itself. The lustrous finish, in addition, must be generated from a smooth surface if it is to have stability. It is also equally necessary that a matte or satin finish be generated from a smooth surface, in order to obtain more than temporary uniformity.

Although the theme of this article is to emphasize the necessity of a smooth surface for the purpose of appearance and stability, such surfaces are also mechanically important. The smoothness of the surface of a metal increases its safety-factor against stress concentrations, fatigue failure and imposed loads or notch sensitivity.

The above data refers to the surface smoothness as it may be perceived by the sense of touch. The terminology of surface conditions or finish as they affect the eye (visual aspects) are as follows:

Specular finish refers to the nearly uniform position of the metal crystals to light rays. Thus, light rays are reflected directly or nearly so, which is to say mirror-like (image) reflectivity occurs.

Diffuse finishes are surface appearances in which the crystals on the metal surfaces are irregularly positioned. Therefore, light rays falling upon such a surface will be reflected at various angles, i.e., relatively no image can be discerned in a surface with a diffused finish.

Matte finishes refer to non-reflective surface appearances, although generally the term is applied to non-reflective colored surfaces. A color on a matte surface appears to be darker than it would appear on a polished surface.

Satin or Butler finishes are, in appearance and light reflectivity, between specular and matte finishes.

Surface Conditions

MILL FINISHES:

Mirror-finished mill sheets are usually only slightly higher in price than regular mill-finished stock. Their uniform finish is often superior to that obtained by buffing after fabrication. Fabrication of mirror finished stock (sheet, coils, flats) in aluminum and brass can be performed with special paper protection on the surfaces.

Under some circumstances centerless-ground (400 grit or finer) tubing eliminates the need of further polishing prior to plating or anodizing.

THREE DIMENSIONAL SURFACE DESIGNS:

Several firms produce a wide variety of rolled-in or pressed-in designs on aluminum and stainless steel sheets, (Fig. 1).

Such three dimensional surfaces serve to break up a plane surface. Additional advantages are that properly relieved surfaces render marks less obvious, and eliminate the need for mechanical polishing and buffing.

Tubing with various surface designs and contours is also available, as shown in Figure II.

Colors of Metals and Metallic Finishes

The natural hues of metal surfaces and metallic deposits may be important factors effecting their selection.

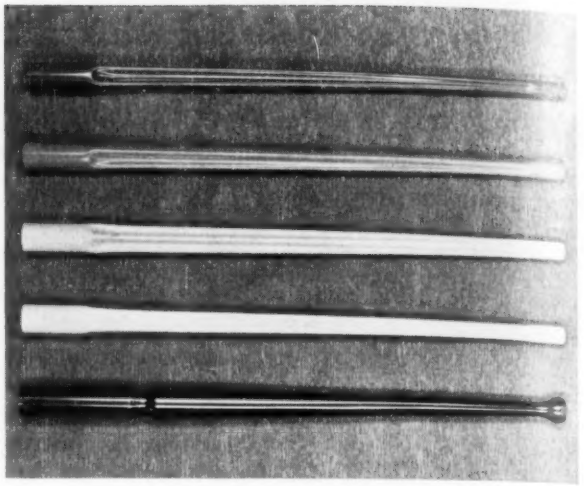
ALUMINUM:

Aluminum has a hue slightly on the blue side. Mechanically-buffed and conventionally anodized aluminum, dependent on alloy and treatment conditions, may have the following surface aspects:

(a) Butler or satin silver,
(b) Antique-silver,
(c) Smooth pearl-gray,
(d) A whitish etched or frosted or scratch-brushed finish, etc.,
(e) Simulated brass, copper and gold,
(f) Any dye-color or hue, except white,
(g) Nickel or chromium finish effects,
(h) Glossy blacks to optical black.

Electropolished and chemically-polished aluminum has an appearance between silver and platinum. The anodic treatment stabilizes the electropolished or chemically polished lustre.

The resistance to atmospheric corrosion of anodized aluminum exceeds that afforded by lacquered and plated deposits on other metals by from 3 to 10 times. Thus, the undyed anodized aluminums have a long life in outdoor exposures. The dyed finishes are not



(Courtesy of Reynolds Metals Co.)

Figure 2—Special shapes available in tubing form.

applicable for *continuous* outdoor exposures. The light-fastness of the dyed metal is similar in a comparative degree to the equivalent dyes on textiles. The anodic film, dyed or undyed, will not peel or lift off, as it is integral with the parent metal. Anodic films provide far greater resistance to abrasion than untreated aluminum.

The lustre and uniformity of anodized aluminum are governed by the following factors.

(1) The chemical nature of the anodizing bath, its operating temperature, the time of anodizing and the applied voltage.

(2) Any one of the alloying elements in excess of the maximum percentages listed below prevents the formation of lustrous anodic films.

Iron—0.5%, silicon—1.0%, manganese—2.0%, zinc—2.0%, copper—5.0%, manganesium 7.0%.

The presence of lead and bismuth in an alloy also detracts from the anodized appearance, therefore, the free machining alloys 317 and 11ST-3 do not have quite as high an anodized lustre as 17ST.

(3) The surface condition of the metal also effects its anodized appearance. Cast aluminum is difficult to anodize with any degree of uniformity, due to excessive porosity. Cold-worked and finely ground or machined wrought alloys respond to anodizing better than unmachined areas.

(4) A far superior anodic finish, as to lustre and stability, results when the aluminum has been electropolished or chemically polished prior to anodizing.

Aluminum and its alloys may be plated upon, subsequent to certain pre-plate treatments. The cleaning procedures and preplate treatments differ slightly for each group of alloys.

No decorative or corrosion resistance advantages occur from plating on aluminum which cannot be surpassed by anodizing, though for technical and functional purposes plated aluminum fills the following applications:

(1) Hard chrome plating for superior abrasion resistance, wear resistance and for a low co-efficient of friction.

(2) Silver plating for electrical conductivity.

(3) Copper plating for a soft solder base, etc.

(4) Brass plating to obtain adherence for rubber or soldering.

The finishing department should be given definite instructions as to the alloy number of each part, as the various alloys respond differently to cleaning, anodizing, dye-coloring and plating treatments. For instance, a non-heat-treatable aluminum requires considerably more anodizing than a heat-treatable alloy in order to approximate an equivalent color after dyeing. In addition, even two parts made of the same aluminum alloy may require care in order to obtain a color match if one of the parts is definitely smaller than the other. Small parts tend to draw greater current density, and so accept deeper colors; hence, less anodic treatment may be required. Aluminum and plastic assemblies may be anodized and dye-colored, with no effect on the plastic as a rule.

Aluminum sand castings and permanent moldings are usually anodized to increase their corrosion resistance and to act as a lacquer base. Such castings, however, are seldom pore-free; hence, they are usually not improved in appearance by anodizing and dye-coloring. The surface appearance of the above types of castings may be enhanced as follows:

(a) Ball-peened and anodized.
(b) Ball-peened, scratch-brushed and anodized.
(c) A very attractive finish is obtained by ball-peening or scratch-brushing followed by electropolishing or chemical polishing. The finish may be stabilized by an anodic treatment.

BRASS:

Brasses are yellow, greenish-yellow, light-golden and red-golden in color.

The buffed brasses should be given treatments to help preserve the finish. Clear lacquering is the more usual application on brass finishes. For best results triple coats of baked lacquer are required. Brass plate on steel is also usually clear lacquered.

Flash gold-plate on brass owes any stability it may have, not to the gold deposit, but rather the quality of the clear lacquer applied.

COPPER:

Copper is red, and when plated for decorative purposes the plate is usually nickel and chromium. This metal is also sometimes given a chemical oxidation or blackening treatment, then clear lacquered to preserve the fugitive colorations created.

MAGNESIUM:

Magnesium alloys are seldom used without some type of surface treatment. Though these alloys may be plated by special processes, the electrolytic (galvanic) activity between the basis metal and the plated deposits is too great for uses other than for indoor purposes.

Magnesium alloys must be given treatments preparatory to lacquering. Certain of the alloys require the Dow No. 7 treatment or equal. Other alloys may be anodized to obtain a suitable base or passive surface for adherence. The painting or lacquering procedure for corrosion resistance and increased adherence of the film, requires one to three prime coats of zinc chromate subsequent to one of the surface treatments noted above. Aluminum lacquer or other types of lacquer follow the primer coat.

Many magnesium alloys respond to anodic treatment and dye-coloring. The dye-colored magnesium alloys do not have the high metallic lustre of dyed-aluminum. The anodic oxide finish on magnesium is less wear resistant and less resistant to atmospheric corrosion than anodized wrought aluminum. Magnesium die castings, however, may be dye-colored with better results than some aluminum die castings.

NICKEL:

Nickel has a yellowish hue. Its atmospheric corrosion resistance, either as a parent metal or a deposit, is not good enough for permanent decorative purposes. Of course, nickel plated brass and steel screws and small screw products predominate in decorative products, for the reason that such small parts may be inexpensively nickel plated in a barrel, but until lately could not be chromium plated in a similar inexpensive manner.

MONEL:

Monel has a copperish hue. It is seldom used as a basis metal for plating or lacquering because of its inherent high corrosion resistance.

STAINLESS STEEL:

Stainless-Steels have a yellowish cast, similar to nickel. Certain types of stainless steels may be anodized to present a limited range of color-tints, and as previously mentioned it may be chemically blackened and electropolished.

An "orange-peel" appearance in stainless steel is a common mill defect. It is usually impractical to attempt the removal of such defects thru polishing. Stainless steels may be plated by special techniques, although there are few calls for it.

STEEL:

By far the largest tonnages of steel finished are pigment-painted (inorganic paints), galvanized, tinned, porcelain-enameled and lacquered (organic paints). Only a fraction of a percent of the steel production is electroplated. The major tonnages of the plated steel is zinc and cadmium deposits for corrosion resistance purposes. The decorative metallic deposits on steel are generally the conventional sequence of copper-nickel-chromium. Also, brass and on occasions other metals or bi-metals are deposited on steel and iron. Processes are offered to produce reflective finishes by means of bi-metal deposition.

About the only common alloys of iron or steel which present any great difficulties to the plater are some malleable and cast irons. Hot-rolled steel is costly to descale and is not as practical for plating as cold rolled steel.

Practically all iron and steel alloys are easily pre-

(*Concluded on page* 81)

Analytical Methods in Plating Baths

By J. B. Mohler and H. J. Sedusky

ANALYTICAL methods are the foundation for plating bath control. Although it is possible to go far in controlling many baths without resorting to control by analytical methods, it is not necessarily desirable. By the use of analytical control it is possible to hold a bath in limits, whereas if control were maintained purely by physical and plating tests the bath would gradually drift away from the original limits. Eventually a point would be reached where radical changes in the bath would be required to again arrive within the original limits. This usually results in temporary shut-down of the tank and loss of time and production.

Analyses are not made to get out of trouble but rather to stay out of trouble. By frequent analyses and continual adjustment of chemicals, baths have been operated for years without trouble.

It is worth while to review analytical methods recommended for plating bath control and it is worth while to take an occasional look at the standard analytical books. Plating methods are rapid and relatively inaccurate compared to standard routine analytical methods. This relative inaccuracy is allowable for the wide limits used for plating control; but it should be realized that, if accuracy is required, a better method may be in order. For instance, such accuracy would be required to check the purity of plating salts.

Analytical methods are dependent on the purpose of the analysis, so that it is not possible to use a single method that will be satisfactory for all applications of the substance sought. A particular method is selected according to the relative importance of the factors: speed, cost and accuracy. Each of these factors assumes a different importance in each application. A method used to control the metal in a flash bath may not be satisfactory to control the metal in a bath used to produce heavy deposits. Likewise, methods used to control a bright plating bath may not be required for a bath used to produce deposits for resistance to corrosion.

Many times it is desirable to have more than one method for the same substance. Two different methods may be used to check one against the other or an analyst may prefer a certain type of analysis. Of the many methods available, the following six methods are examples of various ways of determining copper in a copper cyanide bath:

1. Destroy the cyanides and plate the copper from an acid solution on a weighed platinum cathode.
2. Destroy the cyanides with acid and titrate with sodium thiosulfate.
3. Determine colorimetrically as the blue complex formed with ammonia or by the color produced from copper chloride in a strong hydrochloric acid solution.
4. Determine polarographically by the addition of the proper electrolyte.
5. Precipitate as copper hydroxide and determine the volume of precipitate with a centrifuge.
6. Estimate the copper from the titration of free cyanide and the determination of cathode efficiency.

The selection of one of this number of methods depends on the accuracy desired and the equipment available. If a centrifuge is available for the determination of sulfate in a chromic acid bath it may also be used for the determination of copper. If platinum electrodes are available for the electrolytic determination of copper then these may be also used for the electrolytic determination of cadmium.

Volumetric Methods

The volumetric methods are the most popular general ones in use. These methods are relatively fast and usually quite accurate. They depend on the quantitative completion of a chemical reaction by addition of one solution to another. The volume of the solution that is added to the sample is accurately measured. After the reaction is complete a secondary reaction takes place to recognize that this is so. This secondary reaction is usually recognized by a change in color or by the formation of a precipitate. The accuracy of a volumetric method depends on:

1. The completeness of the primary reaction.
2. The sharpness of the secondary reaction (known as the end-point).
3. The value of the standard solution (usually, expressed as normality).

The chemists have determined the best reactions and the most suitable indicators for a particular method; but it is up to the analyst to be sure of the value of his standard solutions. For plating analyses most standard solutions may be made by weighing enough chemical to make a solution of the desired strength. However it should be realized that accurate solutions require standardization. It is not possible to make a solution of hydrochloric acid that will be .1000N ± .0002N unless the solution is carefully standardized and adjusted. On the other hand it is possible to make a silver nitrate solution of this accuracy since silver nitrate is a pure salt and may be used as a standard for other solutions. As an example: Silver nitrate may be used to determine the value of a hydrochloric acid solution (by neutralizing a known volume of solution and titrating for chloride). Silver nitrate however is limited as a standard since it must be made fresh.

The difference between a fresh solution and an old one is very important. The majority of the standard solutions decompose with age. Solutions must either be made up often, or they must be occasionally standardized. The best standard solutions are those that are stable, for example, a sodium chloride solution. The best methods for standardization are those that use exactly the same steps as the analytical method. The best standard solution to use to standardize silver nitrate for the determination of chloride in a nickel bath would be a standard nickel bath. In other words a nickel bath similar to that being analyzed with a known amount of chloride. As a matter of fact the same nickel bath could be made to serve as a standard for sodium hydroxide solution for the determination of boric acid, and as a standard for sodium cyanide solution for the determination of nickel.

For full appreciation of the use and value of standard solutions and standardization methods it is well to consult the analytical texts.

Gravimetric Methods

Gravimetric methods are not widely used for plating bath control since they are slower than the other types of methods. The gravimetric methods consist of careful separation of a chemical compound from other substances in the bath. The compound is precipitated, washed, dried and weighed. These methods require a balance and an oven, or a furnace, depending on the drying step. The gravimetric methods are generally accurate and are often used for check work where a substance is determined by more than one method.

Electrolytic Methods

Electrolytic methods may come under the general classification of gravimetric methods since the metal is weighed. In the electrolytic methods the metal sought is deposited on a platinum cathode. The metal is then washed, dried and weighed. These methods are usually faster than the other gravimetric methods and are quite accurate. The high accuracy that can be obtained is indicated by the fact that the electric current is standardized in terms of plating silver from a silver nitrate solution.

Cathode Efficiency Methods

The amount of metal in a bath can often be estimated by determination of the cathode efficiency. This may be done by plating at a known current density for a definite period of time. The amount of metal on the cathode may be determined by weighing or it may be determined by deplating at low current density and noting the time required. The methods can only be used if the effect of metal concentration, temperature and concentration of other chemicals on the cathode efficiency be known. The accuracy is only fair, but very rapid methods may be developed.

The Centrifuge

The centrifuge may be used for the rapid determination of a constituent that can be precipitated.[1] Carbonate can be determined by the addition of barium chloride. Sulfate can be determined in a chromic acid bath. Free cyanide can be determined in a cyanide copper bath by the addition of copper sulfate solution. It is possible that many of the metals can be determined where they can be precipitated as a sulfide, hydroxide or other insoluble compound.

The pH Meter

The pH meter is valuable for the direct determination of pH and as a means of recognizing an endpoint where a titration is made to a definite pH.

The Colorimeter

Colorimetric methods are rapid and reasonably accurate where they can be applied. Specific methods must be worked out so that the color is measured at the proper wave length. By such a method nickel may be determined directly in a few minutes. It is not necessary that the solution be colored if it will absorb light rays, as shown by a method used for the determination of nitrate in silver baths.[2]

These methods should only be used where a specific method applies to a specific instrument and new methods may only be developed at the expense of considerable experimentation.

Colorimetric methods are often valuable to determine impurities in plating baths due to their sensitivity to small amounts of metal.[3]

The Polarograph

The polarograph is an instrument that measures the voltage and amperage characteristics of a dropping mercury electrode. It has been applied to the rapid simultaneous determination of copper and zinc in brass deposits.[4] It is obvious that this instrument can be used for the determination of the metal content of most of the plating baths. However, like the colorimeter, much experimental work is required before it can be determined how the instrument will compete with available methods. It is likely that it will be used for the analysis of alloy baths and deposits.

The polarograph, like the colorimeter, may be used to determine small amounts of impurities in plating baths.[5]

Methods Still Needed

There are many constituents that cannot be determined by known methods. Most of these are addition agents. These complex organic substances do not lend themselves to ready analysis; if they are colloidal the analysis may be of no value. One may analyze for gelatine in an acid bath by determination of the total nitrogen content but the analysis will not tell how the bath will operate. Only part of the gelatine does the work of an addition agent, the rest may only be a harmful residue. The only present answer to this problem is to control the bath by regular addition, by observation of the plate or by plating cell control.

Specific Analytical Methods

The following methods are specific for the analysis of a substance in a plating bath. They are listed with

the intent that they be used as a catalog of methods. Alternatives are given and new methods of analysis are suggested so that one may select his own set of analytical procedures. It is well for one to do this since each application may call for a different method depending on the equipment available and the accuracy required. The listing further indicates that many methods may be developed that are not written as specific plating methods. New methods may be developed from standard analytical procedures taken from the analytical texts or from a knowledge of general methods such as the application of a pH meter to analytical work.

Determination of Acids

BORIC ACID-NICKEL BATH:

Pipette a 5 ml. sample into a 250 ml. Erlenmeyer flask. Add 25 ml. of glycerine. Add 0.5 ml. of Bromcresol purple indicator solution. Titrate with N/10 sodium hydroxide until the solution changes to dark green and then to a blue purple.

ml. x 0.166 = oz./gal. H_3BO_3

Note: It is well to standardize the sodium hydroxide with a nickel bath containing a known amount of boric acid. The same size of sample and exactly the same procedure should be used as in the analysis. This will enable the analyst to recognize the proper color change and all errors in the method will be alike during the analysis and the standardization, thus canceling the errors.

UNDERSATURATION METHOD:

Add 3 to 6 grams of boric acid to 250 ml. of bath. Add a few drops of wetting agent (Tergitol). Agitate for one hour. Filter on a small buchner funnel. Wash with 10 ml. of acetone and allow to dry. Pull dry for 15 minutes. Residue contains 20% liquid.

Note: In some plating baths, such as the fluoborate bath, boric acid is very difficult to determine. This method, which may be called a measurement of undersaturation may be used for such an instance. If it is used it is best to redefine the limits for boric acid in terms of undersaturation. For instance, if the limits call for 25 to 35 grams per liter and a saturated bath would contain 45 grams per liter, then the undersaturation limits would be 10 to 20 grams per liter. The residue weighed in the above method is a direct measure of undersaturation where the residue holds 20% liquid. A correction should be made for dry weight or the residue should be dried.

CHROMIC ACID:

Pipette 10 ml. of sample into a 500 ml. volumetric flask. Dilute to the mark and mix thoroughly. Pipette 10 ml. from the volumetric flask into a 250 ml. Erlenmeyer flask. Add 100 ml. of distilled water. Add 2 grams of ammonium bifluoride. Add 15 ml. of concentrated hydrochloric acid solution and 10 ml. of solution containing: 100 grams per liter of potassium iodide and 1 gram per liter of potassium hydroxide. Titrate with N/10 sodium thiosulfate until the brown color fades to straw. Add 5 ml. of starch solution and titrate until the blue color disappears.

ml. x 2.234 = oz./gal. CrO_3

FLUOBORIC ACID:

Fluoboric acid may be determined by conductivity if correction is made for the metal content of the bath.

The correction for the metal content may be made by a gravity measurement.

FREE FLUOBORIC ACID-LEAD FLUOBORATE BATH:

Pipette a 10 ml. sample into a 400 ml. beaker. Dilute to 250 ml. with distilled water. Titrate with N/1 sodium hydroxide until the first permanent white cloudiness appears.

Note: In most analytical procedures recommended volumes are only approximate but in this procedure the recommended volume must be exactly the same for each determination.

ml. x 1.18 = oz./gal. HBF_4

FREE ACID:

Pipette a 25 ml. sample into a 250 ml. Erlenmeyer flask. Add 125 ml. of distilled water and 5 drops of methyl orange indicator. Titrate with N/1 sodium hydroxide.

ml. x 0.196 = oz./gal. HCl
ml. x 0.263 = oz./gal. H_2SO_4

Note: This is a general method for free acid in the presence of any metal that does not precipitate before the methyl orange end-point is reached.

HYDROCHLORIC ACID AND IRON:

Hydrochloric acid can be determined in the presence of iron by the conductivity method providing a correction is made for the presence of the iron. This correction can be made by a gravity measurement. By properly setting up original standards, acid and iron can thus be run by the measurement of conductivity and gravity.

SULFURIC ACID-ACID COPPER:

Pipette a 10 ml. sample into a 250 ml. beaker. Add 100 ml. of distilled water and 5 drops of methyl orange indicator. Titrate with N/1 sodium hydroxide until the color of the solution changes from violet to pale green.

ml. x 0.657 = oz./gal. H_2SO_4

Ammonia

CYANIDE SOLUTIONS:

Pipette a 20 ml. sample into a 1 liter distilling flask. Place 75 ml. of 10% sodium hydroxide solution in the dropping funnel. Pipette 25 ml. of N/10 hydrochloric acid into the receiver and add one drop of methyl red indicator. Slowly run the sodium hydroxide solution into the distilling flask, leaving a small amount in the funnel to act as a seal. Distill off the ammonia and watch that the color of the indicator does not change. Back titrate the excess HCl with N/10 sodium hydroxide. Run a blank to determine the exact ml. of N/10 sodium hydroxide required to titrate 10 ml. of N/10 hydrochloric acid.

(ml. blank-ml. titration) x .0234 = oz./gal. NH_4OH

BRASS BATH:

Monaweck[6] reported that the precipitates of $Na_2Cu(CN)_2$ and CuCN decomposed during distillation to convert CN to NH_3. In order to eliminate these precipitates he suggests the following method:

(1) Pipette a 10 cc sample of the brass solution into an erlenmeyer flask.
(2) Add 25 cc distilled water.
(3) Add 25 cc of cold 1 to 4 H_2SO_4.
(4) Filter off precipitate.
(5) Wash precipitate with 50 cc water.
(6) Evaporate filtrate until SO_3 fumes begin to appear.
(7) Cool and dilute to 250 cc.
(8) Add a few drops of phenolphthalein.
(9) Add $Ca(OH)_2$ solid, until slurry turns pink.
(10) Distill for ½ hour in kjeldahl apparatus, collecting the NH_3 distillate in standard acid.
(11) Titrate excess acid.

(ml. blank-ml. titration) x 0.0468 = oz./gal. NH_4OH

Cadmium

CYANIDE SOLUTIONS-ALCOHOL METHOD:

Pipette 5 ml. into a 25 ml. volumetric flask. Make to the mark with methyl alcohol. Shake and allow crystals to settle. Filter dry into a beaker. Pipette 10 ml. into a 100 ml. beaker. Add 10 ml. of (1-2) hydrochloric acid and 40 ml. of water. Titrate with N/10 potassium ferrocyanide.

ml. x .752 = oz./gal. Cd

CYANIDE SOLUTIONS-ELECTROLYTIC METHOD:

Pipette a 5 ml. sample into a 400 ml. electrolytic beaker. Add 75 ml. of distilled water. Electrolyze with platinum electrodes at 1.5 amps for 2 hrs. using a weighed cathode. Dry and weigh the cathode.

gms. Cd deposited x 26.8 = oz./gal.

CYANIDE SOLUTIONS-VOLUMETRIC METHOD:

Pipette a 5 ml. sample into a 400 ml. beaker. Add 50 ml. of distilled water and 10 ml. of 15% sodium sulfide. Warm the solution and filter off the cadmium sulfide precipitate. Wash the precipitate thoroughly with warm distilled water and discard the filtrate. Transfer the paper and precipitate back to the original beaker. Add 25 ml. of concentrated hydrochloric acid and 25 ml. of distilled water. Heat to boiling to dissolve the precipitate. Dilute to 200 ml. with distilled water and add ammonium hydroxide until a test piece of red litmus paper turns blue. Add concentrated hydrochloric acid until the litmus paper turns red again and add 3 ml. in excess. Heat nearly to boiling and titrate with N/10 potassium ferrocyanide using uranium acetate as an outside indicator.

Note: The presence of zinc will cause an error in this method.

ml. x 0.300 = oz./gal. Cd

Carbonate

CYANIDE SOLUTIONS:

Pipette a 10 ml. sample into a 150 ml. beaker. Add 1 ml. of concentrated ammonium hydroxide and 100 ml. of 10% barium chloride solution. Heat to boiling and boil gently for 10 minutes. Filter and wash prec. with hot water. Add a few drops of barium chloride solution to the filtrate to determine if precipitation was complete. Transfer the filter paper and precipitate to the original beaker. Add 50 ml. of distilled water and a few drops of methyl orange indicator. Titrate with N/1 hydrochloric acid to a permanent pink color.

ml. x 0.71 = oz./gal. Na_2CO_3

Note: The accuracy of this method is only fair, which is all that is usually required. Greater accuracy may be obtained by distilling the CO_2 with sulfuric acid, collecting it by precipitation as it is bubbled through a barium hydroxide solution and then treating the precipitate as above. For greater detail on carbonate analyses consult the analytical books.

CYANIDE BATHS[7]-CENTRIFUGE METHOD:

Pipette a 5 ml. sample into a 100 ml. Goetz centrifuge tube. Add 4 drops of wetting agent and 45 ml. of distilled water. Shake the tube so that its contents are thoroughly mixed. Place in a hot water bath above 200 °F. for 5 minutes. Add 50 ml. of barium chloride solution (25 g/l) also above 200° F. Shake and then replace in hot water bath for 10 minutes. Remove from bath, shake and then spin in centrifuge at 2,000 r.p.m. for 5 minutes. Read the height of the precipitate in the tube and derive the concentration of sodium carbonate in oz./gal. from a prepared standard curve.

Chloride

Pipette 5 ml. of sample into a 250 ml. erlenmeyer flask. Add 50 ml. of distilled water and 1 ml. of 10% potassium chromate solution. Titrate with standard N/10 silver nitrate solution until a reddish color appears.

ml. x 0.095 = oz./gal. Cl

Chromium

TRIVALENT CHROMIUM-CHROMIC ACID BATH:

Pipette 10 ml. of sample into a 500 ml. volumetric flask. Dilute to the mark and mix thoroughly. Pipette 10 ml. from the volumetric flask into a 250 ml. Erlenmeyer flask. Add 100 ml. of distilled water. Add about 0.2 gram of sodium peroxide. Boil for 20 to 30 minutes. Dilute to 100 to 125 ml. and cool. Add 2 grams of ammonium bifluoride and proceed as for the analysis of chromic acid.

(ml. $Na_2S_2O_3$ used for Cr^{+++})—(ml. $Na_2S_2O_3$ used for CrO_3) x 1.16 = oz./gal. Cr^{+++}

Copper

ELECTROLYSIS METHOD FOR CYANIDE SOLUTIONS:

Pipette a 20 ml. sample into a 200 ml. electrolytic beaker. Add 5 ml. of concentrated nitric acid and 5 ml. of concentrated sulfuric acid. Boil until dense white fumes of sulfur trioxide are evolved. Cool. Slowly add 100 ml. of distilled water. Weigh a platinum gauze cathode and set up the platinum cathode and a platinum anode for electrolysis. Lower the electrodes into the beaker until the solution nearly covers

them and start agitation (agitate with a stirrer or with air). Deposit the copper at 4.0 amperes until the blue color disappears and then continue the electrolysis for an additional 15 minutes at 2.0 amperes. Add water so that the level of the solution is raised and an unplated portion of the cathode is exposed to the current. If no further copper deposits the electrolysis is complete. Without interrupting the current stop the agitation and slowly raise the electrodes while washing the cathode down with a continuous stream of water; to prevent resolution of the copper. Rinse the cathode in alcohol, then in ether and dry at 50° C. Weigh. From the gain in weight determine the copper content.

Grams of Cu x 6.7 = oz./gal. Cu

VOLUMETRIC METHOD FOR ACID SOLUTIONS:

Pipette a 2 ml. sample into a 250 ml. beaker. Add 25 ml. of distilled water. Add concentrated ammonium hydroxide until the solution turns dark blue. Boil for 15 minutes. Add 10 ml. of 30% acetic acid solution. Cool to room temperature. Add 25 ml. of 20% potassium iodide solution. Swirl the contents to mix. Titrate with N/10 sodium thiosulfate using starch as an indicator.

ml. x 0.426 = oz./gal. Cu

VOLUMETRIC METHOD FOR CYANIDE SOLUTIONS:

Pipette a 10 ml. sample into a 250 ml. Erlenmeyer flask. Add 5 ml. of concentrated sulfuric acid and 0.5 ml. of concentrated nitric acid. Boil until dense white sulfur trioxide fumes are evolved. Cool. Add 100 ml. of distilled water. Add concentrated ammonium hydroxide until the solution turns dark blue. Boil for fifteen minutes. Add 10 ml. of 30% acetic acid solution. Cool to room temperature. Add 25 ml. of 20% potassium iodide solution. Swirl the contents to mix. Titrate with N/10 sodium thiosulfate solution until the brown color fades to yellow. Add 5 ml. of 1% starch solution and continue titrating until the blue color disappears and does not reappear for at least one minute.

ml. x 0.0852 = oz./gal. Cu

Cyanide

FREE CYANIDE-CYANIDE COPPER:

Pipette a 5 ml. sample into a 150 ml. beaker. Add 100 ml. of distilled water. Add a few drops of 10% potassium iodide solution. Titrate with N/10 silver nitrate to a slight turbidity.

ml. x 0.261 = oz./gal. free NaCN

Note: This method is reliable for control of a Rochelle copper bath but it must be modified to control a high efficiency copper cyanide bath.

FREE CYANIDE-HIGH EFFICIENCY COPPER BATH:

Pipette 10 ml. of bath into a dry flask. Add 3 grams of Rochelle salt and 1 gram of potassium iodide. Agitate until salts are dissolved. Titrate with N/10 $AgNO_3$.

ml. 0.130 = oz./gal. free NaCN

Note: This method will give approximately the same result as the cold titration for a high efficiency sodium bath. For the potassium bath it is believed to be more reliable than the cold titration.

FREE CYANIDE-HIGH EFFICIENCY COPPER BATH:

Place 10 ml. of 10% potassium iodide solution and 40 grams of cracked ice into a 250 ml. Erlenmeyer flask. Pipette 10 ml. of plating solution into the flask and stir until a temperature of 3 to 5° C. is reached. Titrate slowly at this temperature with N/10 $AgNO_3$ until a distinct opalescence appears which is permanent for one minute.

ml. x 0.131 = oz./gal. free sodium cyanide

TOTAL SODIUM CYANIDE-CYANIDE CADMIUM:

Pipette a 2 ml. sample into a 250 ml. Erlenmeyer flask. Add 100 ml. of distilled water, 5 ml. of 100% potassium iodide and 15 ml. of concentrated ammonium hydroxide. Titrate with N/10 silver nitrate to a faint yellow turbidity.

ml. x 0.65 = oz./gal. NaCN

TOTAL SODIUM CYANIDE-CYANIDE CADMIUM:

Pipette a 1 ml. sample into a 250 ml. Erlenmeyer flask. Add 100 ml. of distilled water. Add 5 grams of a dry powdered mixture of 95% by weight of sodium bicarbonate and 5% by weight of potassium chromate. Dissolve the salts. Titrate with N/10 silver nitrate containing 10 ml. per liter of concentrated nitric acid to the first permanent brick red color.

ml. x 1.30 = oz./gal. NaCN

Note: If iron is present or ferrocyanide it will introduce an error in this method.

FREE CYANIDE-SILVER AND GOLD BATHS:

The general method for total sodium cyanide may be used for the determination of free cyanide in gold and silver baths.

TOTAL SODIUM CYANIDE:

Pipette a 10 ml. sample into a 250 ml. Erlenmeyer flask. Add 20 ml. of 10% potassium iodide solution and 100 ml. of distilled water. Titrate with N/10 silver nitrate to the first turbidity.

ml. x 0.130 = oz./gal. free NaCN

Note: This is the general method for determining sodium cyanide. If sodium cyanide alone is present it will measure the total sodium cyanide present. In a silver bath it will only measure free cyanide; and the method may be altered for each bath depending on the metal present.

TOTAL CYANIDE-CYANIDE ZINC SOLUTION:

Pipette a 5 ml. sample into a 250 ml. Erlenmeyer flask. Add 100 ml. of distilled water, 5 ml. of 20% sodium hydroxide solution, and 5 ml. of 10% potassium iodide solution. Titrate with N/10 silver nitrate to a faint turbidity.

ml. x 0.261 = oz./gal. total NaCN

Gelatine

Take a 25 ml. sample. Add 15 ml. of H_2SO_4, 4 grams of $KHSO_4$ and 0.1 gms. of selenium. Digest for 30 minutes. Dilute to 300 ml. Add 40 ml. of 40% sodium hydroxide. Distill into 10 ml. of N/10 HCL.

Titrate the remaining HCL with N/10 NaOH.

Run a blank titration on 10 ml. of N/10 HCL.

(ml. blank-ml. titration) x 0.0502 = oz./gal. gelatin

Gold

ANALYSIS OF GOLD AND GOLD ALLOY SOLUTIONS:

1. Pipette 25 ml. of gold plating solution or the volume necessary to contain 20 to 50 mg. of gold into a 400 ml. beaker. (This size sample is correct for a three to five pennyweight per gallon bath.)
2. Under a fume hood, add 25 ml. of concentrated hydrochloric acid, stir and bring to a boil. Add 5 ml. of concentrated nitric acid. Boil for five minutes.
3. Remove from flame and add slowly with agitation 25 ml. of a 5% sodium hypochlorite solution. Then add 35 ml. water. Mix thoroughly.
4. Boil gently for 10 minutes.
5. Allow to cool and add with stirring 20 ml. of 20% sodium hydroxide solution. From a pipette or burette, add a saturated solution of sodium bicarbonate in portions of 5 to 7 ml. After each addition, stir vigorously and test the acidity by touching a piece of red litmus paper with the end of the stirring rod. (The drop on the stirring rod should be as small as possible.) A faint trace of blue in the litmus paper is taken as the endpoint for the addition of bicarbonate.

If, after the addition of sodium hydroxide, the sample is alkaline, add one ml. of dilute hydrochloric acid at a time until the sample is acid to litmus. Then add bicarbonate as described above.

6. Add 20 ml. of 30% potassium iodide solution all at once with agitation. Allow to stand for two minutes.
7. Add 2 grams of solid sodium bicarbonate and titrate with a standard 0.01 N arsenious oxide solution.
8. When the yellow-red iodide color becomes a pale straw yellow, add 2 ml. of a 1% starch solution and continue the titration to the disappearance of the starch-iodine color.

In the presence of blue colored basic compounds, i.e., copper, it is best to add the starch solution at the beginning.

CYANIDE SOLUTION:

Pipette a 10 ml. sample into a 250 ml. beaker. Add 15 ml. of concentrated hydrochloric acid and evaporate to a syrupy consistency over a water or steam bath. Add 150 ml. of distilled water. Add 25 ml. of 20% potassium iodide solution and 2 ml. of 1% starch solution. Titrate with N/100 sodium thiosulfate to complete disappearance of the blue color. Back titrate with N/100 iodine solution to reappearance of the blue color.

N/100 reagents are not stable enough to use without standardization. Therefore these reagents must be standardized with a known amount of gold. For details see *Plating and Finishing Guidebook.*

Electrolytic Method: Pipette 5 ml. of sample into a 250 ml. electrolytic beaker. Add 200 ml. of distilled water. Add 5 grams of sodium hydroxide and 5 grams of sodium cyanide and dissolve. Electrolyze at 4 to 6 volts for about 45 minutes on a weighed platinum cathode. Rinse with distilled water, dry in an oven, cool and weigh.

grams of Au x 200 = gms./L. Au
x 26.8 = oz./gal. Au

Indium

CYANIDE BATH:

Pipette a 10 ml. sample into a 250 ml. beaker. Add 10 ml. of concentrated hydrochloric acid. Add 25 ml. of distilled water and boil to expel hydrogen cyanide. Add 5 drops of methyl-orange indicator. Add concentrated ammonium hydroxide slowly until the solution turns yellow. Bring to a boil. Filter and wash. Ignite in a good oxidizing atmosphere at about 800° C. Weigh as In_2O_3.

Wgt. In_2O_3 x 11.1 = oz./gal. In

Iron

CHLORIDE BATH:

Pipette a 5 ml. sample into a 250 ml. Erlenmeyer flask. Add 125 ml. of distilled water and 15 ml. of sulfuric-phosphoric mixture consisting of 150 ml. of concentrated sulfuric acid plus 150 ml. of concentrated phosphoric acid diluted to one liter. Add a few drops of diphenylamine solution consisting of 1 gram of diphenylamine dissolved in 100 ml. of 60% acetic acid. Titrate with 0.5 N potassium dichromate until the solution changes from green to violet.

ml. x 0.748 = oz./gal. Fe

SULFATE BATH:

Pipette a 5 ml. sample into a 250 ml. Erlenmeyer flask. Add 100 ml. of distilled water and 5 ml. of a solution of sulfuric acid consisting of one part of sulfuric acid to one part of water. Titrate with 0.5 N potassium permanganate to a permanent pink color.

ml. x 0.748 = oz./gal. Fe

Lead

GRAVIMETRIC METHOD:

Pipette a 10 ml. sample into a 400 ml. beaker. Add 100 ml. of distilled water. Add 10% sulfuric acid until precipitation is complete. Heat almost to boiling and keep hot for 15 minutes. Cool. Filter and wash with cold 1% sulfuric acid. Ignite at 800° C. Weigh as $PbSO_4$.

grams $PbSO_4$ x 9.1 = oz./gal. Pb

VOLUMETRIC METHOD:

Pipette a 5 ml. sample into a 400 ml. beaker. Add 10 ml. of concentrated nitric acid and 15 ml. of concentrated sulfuric acid. Evaporate to dense white fumes. Cool. Add 150 ml. of distilled water and 10

grams of tartaric acid. Heat to boiling. Cool. Filter off the lead sulfate and wash with cold water. Transfer the paper to the original beaker and add 30 ml. of a saturated solution of ammonium acetate. Add 150 ml. of distilled water. Heat to boiling and titrate the hot solution with standard ammonium molybdate solution using tannic acid as an external indicator. The end-point is the first faint yellow color.

ml. x 0.134 = oz./gal. Pb

Nickel

Pipette a 5 ml. sample into a 250 ml. erlenmeyer flask. Add 50 ml. of distilled water and 0.5 ml. of 10% potassium iodide solution. Add concentrated ammonium hydroxide until the solution turns a clear blue. Add 0.5 ml. of N/10 silver nitrate. Titrate with 0.5 N sodium cyanide until the precipitate which first forms just redissolves.

ml. x 0.393 = oz./gal. Ni

Resorcinol

Take a 10 ml. sample. Dilute to 50 ml. Add 2 grams of 20 mesh zinc and allow to stand for 10 minutes. Add 50 ml. of water and 5 ml. of hydrochloric acid and allow to stand 30 minutes longer. Filter and wash. Add potassium bromide and standard potassium bromate solution. Allow to stand for 15 minutes. Add potassium iodide. Allow to stand 15 minutes and titrate with N/10 sodium thiosulfate. Run a blank exclusive of the sample and the addition of zinc but with the timing the same as the sample, to determine the value of exactly 50 ml. of potassium bromate.

(ml. blank-ml. titration) x 0.0245 = oz./gal. Resorcinol

potassium bromate solution	3.00 g./l.
potassium bromide solution	250 g./l.
potassium iodide solution	25%

Note: For bromination methods for other organic compounds see, *Kolthoff and Furman* Vol. II, pg. 476.

Rochelle Salt

CYANIDE SOLUTIONS:

Pipette a 5 ml. sample into a 250 ml. volumetric flask. Add 100 ml. of distilled water and a particle of solid phenolphthalein. Add 1% sulfuric acid solution drop by drop until the pink color just disappears. Add exactly 5 ml. of nitrobenzene. Add 10% silver nitrate solution drop by drop until the color of the precipitate changes from white to blue-grey. Shake ½ minute to coagulate the precipitate. Allow to settle and add one drop of silver nitrate to determine if precipitation is complete. Bring the solution to the mark, add exactly 5 ml. of distilled water above the mark and shake thoroughly. Allow to stand until the precipitate has settled. Pipette 50 ml. into a 500 ml. Erlenmeyer flask. Add 5 ml. of 20% sulfuric acid, 5 grams of manganese sulfate and 100 ml. of distilled water. Heat to about 70° C. Add slowly and with agitation exactly 20 ml. of N/10 potassium permanganate solution. Allow the hot solution to stand for 5 minutes. Cool to room temperature under running water. Add 2 grams of solid potassium iodide and 2 ml. of 1% starch solution. Shake the flask for a few seconds. Titrate with N/10 sodium thiosulfate until the blue color disappears and does not reappear for at least one minute.

Note: The potassium permanganate and sodium thiosulfate should be standardized for this method.

6.28 (20 x N of $KMnO_4$-ml. $Na_2S_2O_3$ x N of $Na_2S_2O_3$) = oz./gal. $KNaC_4H_4O_6.4H_2O$

Silver

Pipette a 5 ml. sample into a 250 ml. beaker. Add 100 ml. of distilled water and 10 ml. of 15% sodium sulfide solution. Heat to boiling. Filter and wash the precipitate with hot water. Transfer the paper and precipitate to the original beaker and add 50 ml. of (1-2) nitric acid. Boil to dissolve the precipitate. Add 10 ml. of 10% ferric ammonium sulfate. Titrate with N/10 potassium thiocyanate solution to the appearance of a pink coloration.

ml. x 0.372 = oz./gal. AgCN

Electrometric Determination: This method illustrates how a cell may be set up to titrate to a definite potential. The method is similar to titration to a definite pH with a pH meter except that a system has to be used that will measure the potential of the metal ion rather than the hydrogen ion.

An apparatus was developed so that both free cyanide and silver could be determined from one titration.

Cyanide Strike Bath: Silver can be determined in a silver strike bath by plating and deplating. Such a method is a rapid method of determining the cathode efficiency. The cathode efficiency is a measure of the silver concentration. By dilution of a silver bath with a sodium cyanide solution such a method may be used for the determination of silver in a standard silver cyanide bath.

Cyanide Bath: Pipette 10 ml. of bath into a 400 ml. beaker. Dilute to 100 ml. Add nitric acid drop by drop until the color of phenolphthalein is just discharged. Boil to coagulate the precipitate. Filter on a weighed gooch or fritted glass crucible. Wash. Dry at 105° C. for one half hour and weigh as AgCN.

gram AgCN x 10.8 = oz./gal. Ag

Sodium Acetate

Pipette a 25 ml. sample into a 500 ml. distilling flask. Place a few glass beads in the bottom of the flask. Fit the flask with a two hole rubber stopper, one hole containing a thermometer and the other a dropping funnel. Connect the side arm of the flask to a condenser. Add 175 ml. of distilled water and 25 ml. of concentrated sulfuric acid through the dropping funnel. Distill into a 500 ml. erlenmeyer flask containing 50 ml. of distilled water. Continue distillation until the temperature reaches about 127° C. Add more water and continue distillation until 250 to 300 ml. of water have been distilled over. Add 0.5 ml. of sulfo-orange indicator and titrate with 0.5 N sodium hydroxide to a yellow endpoint.

ml. x 0.220 = oz./gal. Sodium Acetate

Sodium Hydroxide

Pipette a 5 ml. sample into a 250 ml. erlenmeyer flask. Add 25 ml. of distilled water and 0.5 ml. of sulfo-orange indicator. Titrate with N/10 hydrochloric acid to a yellow endpoint.

ml. x 0.107 = oz./gal. NaOH

Cyanide Cadmium Bath for Sodium Hydroxide: Pipette a 5 ml. sample into a 250 ml. erlenmeyer flask. Add 50 ml. of distilled water and 10 ml. of 10% sodium cyanide. Add 0.5 ml. of sulfo-orange indicator. Titrate with standard 1.0 N hydrochloric acid until the color changes from orange to yellow.

ml. x 0.0107 = oz./gal. NaOH

Sodium Cyanide: Sodium hydroxide can be controlled by conductivity in the presence of sodium cyanide, providing the sodium cyanide is determined by titration and a correction for the effect of sodium cyanide on the conductivity is determined.

Sodium Thiocyanate

Pipette a 10 ml. sample into a 250 ml. erlenmeyer flask. Add 100 ml. of distilled water. Add sulfuric acid drop by drop until the solution just turns blue litmus to red. Add 0.5 ml. of saturated ferric ammonium sulfate solution. Titrate with standard 0.1 N silver nitrate solution until the red color disappears.

ml. x 0.109 = NaCNS

Sulfate

CHROMIC ACID BATHS:

Pipette a 10 ml. sample into a 250 ml. beaker. Add 75 ml. of a reducing mixture consisting of 15 parts by volume of isopropanol, 7 parts of concentrated hydrochloric acid and 25 parts of glacial acetic acid. Dilute with hot water to between 125 and 150 ml. and let stand for at least one hour at 60 to 70° C. Filter into a 250 ml. beaker and wash the green coloration from the paper with hot water. Heat the filtrate to boiling and add, drop by drop, 10 ml. of 10% barium chloride solution. Allow to settle for 2 to 4 hours at 60 to 70° C. Filter and wash thoroughly. Ignite the paper and precipitate in a weighed porcelain crucible at bright red heat for about 15 minutes. Cool and weigh.

grams $BaSO_4$ x 5.64 = oz./gal. H_2SO_4

Chromic Acid Ratio: The CrO_3:SO_4 ratio of a chromic acid bath can be determined directly from a plating range test if plating range standards are available. This method has the advantage that the bath may be adjusted to the widest plating range by test rather than relying on chemical analysis for SO_4 to produce the widest plating range.

Tin

Alkaline Tin Bath: Tin can be determined in an alkaline tin bath by using a rapid plating and deplating method for the measurement of cathode efficiency. If such a method is used the temperature and caustic concentration effects will have to be taken into account.

STANNOUS TIN-ACID TIN BATH:

Pipette a 10 ml. sample into a 500 ml. Erlenmeyer flask. Add 150 ml. of distilled water, 20 ml. of concentrated hydrochloric acid and 2 ml. of starch solution. Titrate with 0.1 N iodine solution.

ml. x 0.0795 = oz./gal. Sn

TOTAL TIN-ACID BATH:

Pipette a 10 ml. sample into a 500 ml. Erlenmeyer flask. Add 150 ml. of distilled water, 10 ml. of concentrated hydrochloric acid and 1 gram of powdered iron. Attach an outlet tube and boil for 30 minutes to dissolve the iron and reduce the tin. Place the flask in a cooling bath with the outlet tube submerged in saturated sodium bicarbonate solution. When cool, remove the outlet tube, add starch and titrate with 0.1 N iodine solution.

ml. x 0.0795 = oz./gal. Sn

Zinc

Cyanide Solution No. 1: Pipette 5 ml. into 25 ml. volumetric flask. Make to the mark with methyl alcohol. Shake and allow the crystals to settle. Filter dry into a beaker. Pipette 10 ml. of filtrate into a 100 ml. beaker. Add 10 ml. of (1-2) hydrochloric acid and 40 ml. of water. Add 1 ml. of 10% sodium sulfide. Titrate with N/10 potassium ferrocyanide.

ml. x 0.438 = oz./gal. Zn

Cyanide Solution No. 2: Pipette a 5 ml. sample into a 250 ml. beaker. Add 25 ml. of distilled water and 10 ml. of 15% sodium sulfide solution. Heat to boiling and filter off the precipitate. Wash with hot water and discard the filtrate. Transfer the filter paper and precipitate back to the original beaker. Add 10 ml. of concentrated hydrochloric acid and 1 to 2 grams of sodium sulfide crystals. Boil to expel hydrogen sulfide. Dilute to 150 ml. with distilled water and heat to boiling. Titrate with N/10 potassium ferrocyanide using 5% uranium nitrate as an outside indicator. The endpoint is reached when the addition of 1 drop of the solution being titrated to two drops of uranium nitrate in the spot plate produces a reddish-brown precipitate.

ml. x 0.175 = oz./gal. Zn for N/10

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Heavy Nickel Deposition as a Manufacturing Operation

By S. Wernick, Ph.D., M.Sc., F.R.I.C., F.I.M. and F. Willetts, F.I.M.

A process of nickel deposition is described which was developed for a specific purpose—to produce a "heavy" nickel coating on a cast iron base, free from nodules and possessing physical characteristics enabling the deposit to be readily and economically ground to size. The process is now in everyday use as one of the links in a manufacturing chain of operations.

Introduction

APART from their decorative and protective properties, nickel deposits have also found considerable application in salvaging worn, damaged or undersized components. The process employed in the latter application has become known as heavy nickel plating, due to the much thicker deposits which are applied for the purpose. The object of this paper is to describe a specialized application of heavy nickel deposition, in that the object is not to repair or salvage components, but to apply a heavy coating of nickel as part of a chain of manufacturing operations, involving its incorporation as a routine manufacturing process. The authors believe that such an application is novel, and its development to the stage of works' processing was, as may be inferred, only made possible by the solution of a number of special problems which were encountered during the development stages.

Fig. 1—Jig developed for piston components.
(1) Unloaded.
(2) Loaded ready for deposition.
(3) After nickel deposition.

The particular component to which this process was applied is a cast iron piston employed in an assembly which is incorporated in an apparatus for measuring liquids by the simple displacement of such pistons operating in a cylinder block. The latter is a casting with four cylinders, arranged radially, each pair being exactly opposite to the other. The unit operates in a horizontal position, the opposite pistons being fixed together, and therefore the bottom side of the cylinder walls carry the weight of the pistons. The unit itself is operated by a pump which forces the liquid into the central cavity under low pressure. The co-efficient of friction between pistons and cylinders must necessarily be low, so that the slightest pressure of liquid is sufficient to operate the unit, the liquid itself being discharged through various ports to the free outlet. Very close dimensional tolerances are essential throughout.

Initially, the whole unit was made of non-ferrous castings, the block being of manganese bronze and the piston of phosphor bronze. For various reasons it was then decided to make the cylinder block itself in cast iron, lining the bores with white metal. The rigidity of cast iron was the principal determining factor, this effecting a considerable improvement in design, whilst, obviously, the substitution of non-ferrous castings by ferrous was undoubtedly economic. As regards the piston, this, too, was changed to an iron casting, the problem then being to employ a suitable coating for the surface. The principal requirements of the latter were high corrosion resist-

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Fig. 2—General layout of nickel deposition plant.

ance, adequate wear resistance, minimum friction and capacity for self-cleansing.

At first, experiments were carried out with heavy chromium plating. Difficulties were then encountered in grinding, due to the fact that while the deposits were grindable, this proved to be uneconomic and impracticable, since it would have necessitated a large number of grinding machines, considerably more labor and a corresponding heavy stock of grinding wheels. Nitriding of the cast iron pistons proved equally unsatisfactory because the corrosion resistance was poor.

Attention was then turned to the possible use of nickel as a deposited coating. Heavy nickel deposits were accordingly applied by outside specialists in the industry, and experience with these soon indicated that application of the normal heavy nickel procedure was not suitable, due to the fact that (*a*) the deposits were nodular, (*b*) they necessitated considerable grinding, which was uneconomic, and (*c*) they were often too tough when recourse was made to turning instead of grinding.

Machining Difficulties

It is, of course, well known that much development has taken place in heavy nickel deposition to replace worn or over-machined parts, particularly large gun parts and engine crankshafts. Here, machining is not a serious problem, since obviously the comparative reduction in time which is possible by machining a nickel-plated part makes the operation eminently worth while on such components. It was, therefore, with some surprise that the authors encountered, in the present application, a bottle-neck in production in the operation of turning off a few thousandths of an inch of nickel prior to final grinding. Nickel, obviously, can readily be turned in a capstan lathe, but to turn it on a production basis with unskilled labor on semi-automatic machines is quite another matter. Variations in the hardness of the deposited nickel between 150 and 260 Brinell were tried with no better results.

Again, variations in the shapes of cutting tools, speeds and feeds still failed to give that continuity of production which was essential. The best "run" obtained was no more than two hours, but it could not be repeated continuously. The average was between 30 and 60 minutes, during which time no more than 10 to 20 pistons could be completed. In effect, under such conditions, machines (and operators) were idle for as much time as they were working, and, as is well known, tool grinding and setting up of machines to close limits is an expensive and unproductive process.

The problem, therefore, hinged on the possibility of producing a nickel deposited component within easy grinding allowance, or, ideally, where no machining or grinding would be necessary at all. The requirements of this particular component are such that only fine grinding can give the accuracy required—namely, ovality of the order of 0.0001 in. maximum, and taper on the length of 0.0001 in. maximum, the component itself being 2.750 in. diameter and 3.250 in. in length.

It was decided that a minimum of 0.005 in. nickel thickness was essential. In order to be sure of this, it was initially estimated that an increase amounting to 50 per cent should be allowed for machining errors. It is obviously almost impossible from a practical standpoint to take a cylindrical job from a mandrel and to put it back again in exactly the same position, since an error of position of 0.001 in. is equal to 0.002 in. on the diameter. Obviously, electro-deposition to this order of accuracy without subsequent grinding would be a difficult thing to maintain. The problem, therefore, was to put on the minimum coating of nickel which would clean up true, depositing a coating of an average thickness of 0.0075 in., and not less than 0.005 in. in thickness at any point. Smoothness, evenness, freedom from lumps or roughness, were essential to make grinding possible. Any preliminary rough machining operation or hand chipping were ruled out as undesirable.

Eventually, the essential conditions which any suitable process would have to satisfy were set down as follows: (1) Deposits to be smooth and even, and free from nodules; (2) The minimum of nickel only to be deposited, so that it would be necessary only to remove a thin superficial nickel film; (3) Close uniformity of product as between different components produced in a given batch.

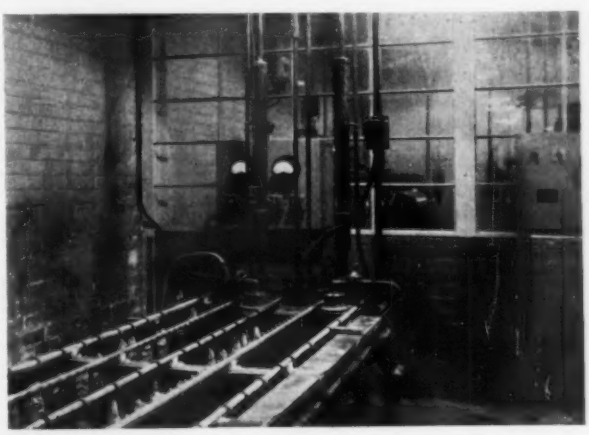

Fig. 3—Detail of nickel plant showing remote-control panel.

This in turn necessitated:

(1) *Close control of the nickel depositing process* (*a*) chemically, (*b*) electrically, (*c*) mechanically.

(2) *The development of correct machining technique of the nickel deposits.*

Nickel Deposition Process

(*a*) *Chemical Considerations*: The chemical methods employed in depositing the nickel, *i.e.*, with respect to preparatory sequence of cleaning operations and the electrolyte employed, show little divergence from what is now considered to be good standard practice. Laboratory control, however, was early instituted to ensure that these conditions once specified were closely maintained.

The sequence of operations was as follows: (*a*) Degreasing in trichlorethylene. (*b*) Jigging of components. (*c*) Soak in alkali cleaner, consisting of the following solution: trisodium phosphate, 8 oz. per gal.; sodium metasilicate, 2 oz. per gal.; time, 10 min.; temperature, 200° F. (*d*) Swill (agitated). (*e*) Electrolytic alkali clean in the following solution: trisodium phosphate, 6 oz. per gal.; sodium metasilicate, 2 oz. per gal.; time 10 min.; temperature, 180° F. (*f*) Swill (agitated). (*g*) Immersion in 5 per cent sulphuric acid (by weight): Time, 5 sec. (*h*) Electrolytic etch in sulphuric acid electrolyte containing: 30 per cent H_2SO_4 (by weight); current density, 200 amp. per sq. ft.; time, 20 to 30 sec. (*i*) Swill and lightly scrub. (*j*) Swill (agitated). (*k*) Nickel plating in an electrolyte containing: nickel sulphate, 40 oz. per gal.; nickel chloride, 3 oz. per gal.; boric acid, 4 oz. per gal.; pH, 5.7; current density, 5 amp. per sq. ft. for a period of 15 min. (minimum) to allow components to reach solution temperature, thereafter current density increased to 25 amp. per sq. ft. for a period of 500 min.

The various solutions were thermostatically controlled, while in the case of the nickel solution the temperature was continuously recorded, as was also the pH (automatically).

(*b*) *Mechanical Considerations*: Precautions to ensure the exclusion of foreign matter both visible and semi-colloidal from the nickel solution as far as possible consisted in efficient filtration and the housing of the plant under as dust-free conditions as possible. With regard to the former, a filtration rate was specified which resulted in the electrolyte being pumped out and back through the filter (which consisted of a built-up layer of Kieselguhr) every hour. In order to prevent particles of nickel oxide entering the electrolyte from the anodes, special anodes were employed having a small carbon content which forms a carbonaceous layer on the anode surface, and effectively holds back insoluble impurities. These anodes were enclosed in double-layer bags.

Fig. 4—General view of power room, showing control equipment.

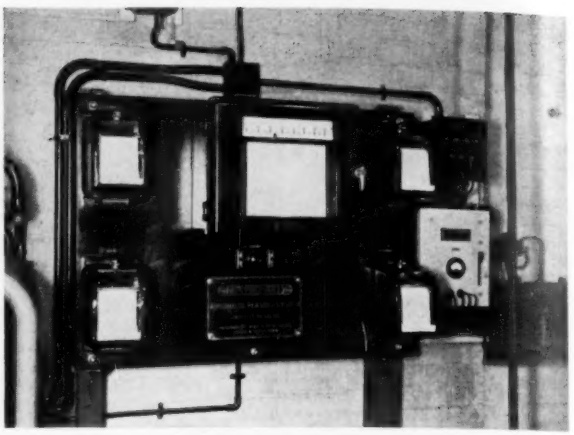

Fig. 5—Control and recording equipment, including pH, a.c., d.c. and temperature-recording apparatus.

Design of Jigs

One of the most important contributions to the production of a smooth, even deposit free from nodules, was the development of a special jig to carry the pistons. The object of the jig was (*a*) to deposit the nickel where it was wanted, (*b*) to prevent its deposition on high current density localities, where nodules normally form. The initial attempt to comply with these conditions was to make use of wax as a stopping-off medium. This, of course, is well-known practice in heavy nickel plating technique. Experiments soon indicated, however, that it was not a desirable method to employ in work of this description. In the first place, the shape of the component made the waxing operation difficult and tedious, while waxing is never at the best of times a clean operation, the wax percolating on such parts of the jig as it was particularly desired to keep clean and being difficult to remove thereafter. The more serious objection was the fact that where the wax was trimmed, the nickel deposit had a natural tendency to build up and produce the very nodules it was desired to avoid. By eliminating the use of wax it was found that the nickel deposit formed a more gradual gradient at the edges, and with the use of protecting shields, correctly spaced, nodular formation was avoided.

Of the insulating materials tested, a Bakelite-canvas composition was found to be most suitable for the purpose. Synthetic resins which were employed initially were abandoned because, while they have many desirable features, they lack somewhat in resistance to mechanical handling; for example, sharp corners, as a result, tend to become jagged.

Fortunately, the piston has a center hole ½ in. in

diameter, and thus lends itself admirably to mounting on a bar with suitable spacers of insulating material. A 7/16 in. diameter brass rod was used as a main support, and spacers, designed as shown in Fig. 1, employed. At each end of the piston is a conical seat, which again lends itself well to location in the plating jig. It was found possible to mount four pistons on one jig with spacers of suitable lengths. Early experiment indicated that a small amount of nickel became deposited on the ferrules, although well hidden, binding them closely to the piston and causing difficulty in dismantling. Furthermore, the rough edges of any torn nickel are, as is well known, dangerous to handle and removal ready for use again was correspondingly difficult. This trouble was overcome by covering with rubber rings, which were assembled at the same time as the pistons. The clamping nut at the lower end was made of the same Bakelite insulating material.

The jig itself is carried on a short handle with a spherical seat, and this, in turn, is carried in a small box, contact being maintained by spring loading. By fitting a peg just below the box, it is a simple matter to identify the side facing the anodes, and therefore an equally simple matter to turn them at right angles in the electrolyte, while they are being plated. This simple device eliminated the necessity for having any elaborate rotary mechanism over the components. In actual practice, it was found that only one turn was necessary, about half-way through the plating cycle, to prevent ovality.

A small amount of nickel is deposited on the inside facing of the piston. This is not harmful or even wasteful, because, in fact, it has a useful function in tapering off smoothly the deposit from the edges, combating nodular formation. This idea is quite practicable with shafts—the shielding being carried out with cones instead of there being a local sharply cut-off line.

A further important feature of the jig assembly was the fitting of two discs above and below the components so as to prevent build-up at these points of maximum current density. The two metal discs may be of brass or steel, and are made of thin-gauge metal, fitted about 1 in. above and below the upper and lower pistons respectively. These build up in nickel, and last about a month of continuous working, but are easily and cheaply replaced. Finally, in view of the weight of the jig when loaded (about 9 lb.) a ring was brazed on the top of the hook so as to facilitate easy handling by the operator.

Under mechanical considerations, mention may also be made of the physical condition of the nickel deposits as produced, which, to function efficiently, must be free from stress. The hardness of the nickel deposited is approximately 180 Brinell, and the deposit is ordinarily stress-free, but to ensure that no possible cracking or parting of the deposit might occur in service, it was decided that all components should be stress relieved. This was carried out by the immersion in an oil tank suitably heated.

(*c*) *Electrical Considerations*: It was felt at the outset that the process once approved and in operation must be rendered as fool-proof as possible, and that the only way to do this would be to employ plant and apparatus which would, as far as possible, hold the specified conditions of operation inside a given range, correcting automatically any divergence resulting from either mishap or mistake on the part of those operating the process.

The obvious conditions which had to be controlled in order to ensure a standard product, were, primarily, (1) the amperage, (2) the time cycle, and, secondarily, (3) the pH of the nickel electrolyte, and (4) the temperature of the electrolyte. Arising from (1) it was considered desirable to incorporate apparatus which would provide a record not merely of the current entering the electrolytic circuit, but also the power input into the rectifier, which would indicate variation on this side of the power aspect. (It was not realized at the time how very important this provision might prove at a time when the electric power from the local generating station may show considerable variation, as it did in the winter of 1946-47, as a result of which this special control proved to be of extraordinary value.)

It was felt, too, that incorporated in the system there should be an alarm unit to warn the operator of any violent change in the current conditions, which should be both visual and audible. Warning lamps were accordingly fitted to indicate when the equipment was operating satisfactorily and when the current had drifted beyond the pre-set limits. A system whereby an alarm is given when the current exceeds or falls below certain pre-set limits is not novel, but under such a system it is left to the operator to adjust the current to its desired value, and, furthermore, to switch off the current when deposition is complete. This was considered to be entirely inadequate for the purpose in mind, and an automatic control system on the following lines was developed:

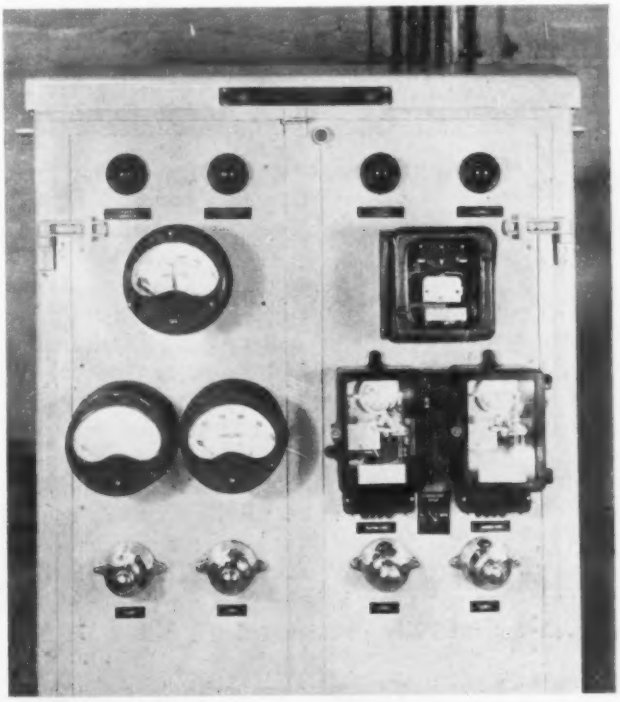

Fig. 6—Control panel for pre-set amperage and time of deposition cycle.

The system applied an initial current for a given short deposition period, during which components took up the temperature of the nickel electrolyte. Thereafter, an amperage was automatically applied, which was pre-set and equal to that specified as being the current required during the remainder of the deposition cycle. Any fluctuations outside a certain narrow range were corrected automatically by means of an electrical system which had been specially designed for the purpose. This entailed the design and manufacture of novel control gear[1] which, so far as the authors are aware, had not previously been employed in heavy nickel plating.

The power plant comprises the following main parts: (*a*) An oil-immersed rectifier rated at 1,000 amperes at up to 7 volts. (*b*) An automatic control cubicle which includes the pre-set features for current value and time of deposit. This is under the control of the supervisor, and is not accessible to the plating operators. (*c*) The panel carrying the recording instruments. (*d*) The plater's control panel, with push buttons, indicating ammeters and voltmeters and alarm lamps.

The automatic control cubicle includes a contact ammeter which can be pre-set to hold the current within close limits, any attempt to deviate beyond these limits causing a voltage regulator to operate and restore the current to the correct value.

Two time switches are included in the cubicle—one for the duration of loading, allowing for the work to attain bath temperature, and the other controlling the duration of the plating process. The recording panel provides a permanent record of the amperage, time of deposition, the bath temperature and pH, so should any query arise, evidence of the full history of the process is available. This proved to be invaluable during the experimental set up of the process.

Stand-by Power Supply

If the a.c. power supply should fail during the plating process, the work in the bath may be spoiled if not removed at once, and may have to be stripped and prepared for deposition again. In the case of heavy nickel deposition, the process may occupy several days, so an interruption in the mains supply towards the end of the plating cycle will involve heavy expense.

To guard against this possibility, a large capacity battery is connected to the bath, through a rectifier element, which permits the battery to discharge freely into the bath and so provide a polarizing potential to the work, but over-charging of the battery by the main rectifier is avoided by the high reverse resistance of the rectifier. A single lead cell provides an adequate polarizing potential for a nickel bath, but as the bath normally operates at about 4 volts, the battery could not be left connected unless the auxiliary rectifier were inserted to prevent over-charging. The alternative change-over contactor, hitherto used for this purpose, which automatically disconnected the bath from the d.c. source and brought into circuit the stand-by battery, is thereby avoided. The auxiliary rectifier has to carry the relatively small depolarizing current, so occupies a small space, compared with the change-over contactor which had to carry the full plating current.

A rheostat of high ohmic value is connected in parallel with the rectifier to permit a small trickle charge to the battery from the main rectifier. The batery is recharged after a supply failure, or given a short gassing charge after topping up to distribute the electrolyte, by short-circuiting the rectifier by means of a switch, and adjusting the current on another rheostat. A center zero ammeter records the charge or discharge current, and it will be seen that under all conditions the battery is free to discharge into the bath whenever the voltage of the main rectifier falls below that of the battery.

The Development of Correct Machining Technique

The question whether a job shall be machined by grinding or cutting with high speed steel tools is often a matter for debate, but, generally speaking, where large amounts of metal have to be removed, cutting with high speed steels is accepted as the quickest and most economical method. Grinding, generally, has greater application for the removal of relatively small amounts, and for greater accuracy, where components cannot be cut with high speed tools, such as hardened components.

In the case of a cutting tool, it is only the point which determines the size of the finished job. The

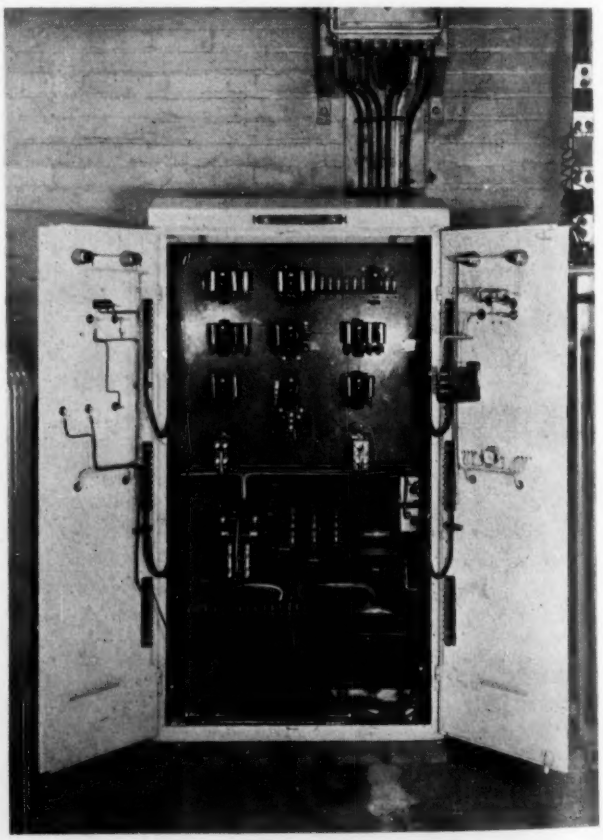

Fig. 7—Interior of control panel shown in Fig. 6.

[1]Ashby & Wernick: Control apparatus for the production of uniform deposits from a rectified a.c. supply. Jan. 1947. Monthly Review, Amer. Electroplaters' Soc., New York.

Fig. 8—Pistons carrying hard chrome (left) and heavy nickel deposits (center and right).

whole of the cutting edge determines how much metal is to be removed. In the case of the pistons, on which nodular metal had been deposited it was felt at first that the correct procedure would be turning, since this would require only 33 to 50 per cent of the time required for grinding.

Nickel is notably tough in machining, and when ordinary high speed tools were tried the points simply rubbed off, the action being more like lapping than cutting. Consequently, although various combinations of cutting angles, top and bottom rakes, etc. were tried it was found impossible to maintain size, while additionally, taper was produced. Tungsten carbide and diamond tools were only found to be efficient up to a point, but as the cutting on the piston is intermittent, both types of tools were found to chip.

Machining of these components under such circumstances, using mass production methods with semi or unskilled labor and automatic or semi-automatic machines became impracticable. It was at this point that the job threatened to break down, and it was felt that special attention would have to be devoted to the nickel plating to make it more practicable and economical for grinding rather than turning. In effect, it involved a co-operative effort on the part of machining engineers and chemists, with the result that a production schedule sheet was brought into operation.

The production schedule sheet shows nine machining operations, preparatory to plating, eight operations in the plating itself and seven machining operations after plating.

The results achieved by the exercise of the controls described above have considerably simplified the final machining. This has been reduced to a matter of "sizing," the operations being carried out as follows: (1) Rough grinding to size plus .005 in. (2) Sizing ends by a very light cut on a lathe. (3) Size milling gap. (4) Final grinding of cylindrical face—the area of the component which really matters.

With regard to the latter operation, the amount of nickel removed is 0.005 in. on the diameter. The finished size is pre-determined to 0.0001 in. on diameter. It is obtained on a John Lund (Precimax) cylindrical grinder fitted with a very accurate stop and time sizer, which means that the grinding continues with no further feed for a predetermined time (a matter of seconds) after the component has reached the predetermined dimension. The wheel used is Carborundum or Aloxite (18 in. diameter by 2 in. face), and the lubricant is soluble oil—40 to 1. Finish produced is of the order of 5 to 6 micro in. The times for the whole final grinding operation is approximately 3 min. with a 20-sec. dwell on size.

Acknowledgment

The authors desire to thank the Directors of Messrs. W. and T. Avery Ltd. for permission to describe the process, which is in full-scale operation at the company's works at Soho, Birmingham.

THE RELATION OF FINISHING TO DESIGN, MATERIALS AND PROCESSING METHODS

(*Concluded from page* 67)

pared for lacquering or painting. To obtain the best adherence for coatings, the surface must be descaled (pickled), degreased or cleaned and phosphatized.

ZINC

Zinc die castings are plated for decorative appeal. The usual deposits are the same as for steel.

Prior to lacquering, zinc die castings should be given a chemical or anodic treatment. Otherwise, poor adherence of the coating may occur. Zinc die casting may be given a black appearance with one of the proprietary blackening solutions. The color may then be given a rich depth and stability by clear lacquering.

Metal Color Harmony

Any metal with a discernible blue, such as chromium plate or un-anodized aluminum, does not form a pleasing color combination with a metal that has a yellowish cast. Metals with a yellowish cast are nickel, 18-8 stainless-steel, and silver. Though silver is white when freshly buffed and lacquered, it soon takes a tarnish even thru the lacquer. The silver tarnish gives a yellowish hue.

Aluminum is about the only metal which may be integrally surface finished so as to present hues that harmonize or contrast (as may be desired) with any other material.

Shop Problems

Abrasive Methods—Surface Treatments—Control
Electroplating—Cleaning—Pickling—Testing

METAL FINISHING publishes, each month, a portion of the inquiries answered as a service to subscribers. If any reader disagrees with the answers or knows of better or more information on the problem discussed, the information will be gratefully received and the sender's name will be kept confidential, if desired.

Tank Linings

Question: I have two old tanks that I want to reline myself for plating cold white nickel and silver. What would be the best thing to reline these tanks with?

O. G. C.

Answer: If you are going to reline the tanks yourself, I suggest that you use a good chemical-resistant paint developed for this type service. The names of suppliers are being sent to you. The tank should first be thoroughly scrubbed out, then the inside scraped or sandblasted down to the bare metal to remove any old material and rust before proceeding with the painting. Several coats will be required to build up an adequate thickness, and each coat should be thoroughly dried before applying the next one. The manufacturers issue complete instructions with their materials. I suggest that you use a white paint for both solutions. This will be especially beneficial in the case of the silver bath, as the transparency of the solution will enable you to see the bottom of the tank to retrive any objects that may have dropped off the plating racks.

Anode Areas in Silver Plating

Question: I am having trouble in my silver plating when I put several pieces in the tank at once. When I plate them one at a time they plate all right, but when several of the same parts are in the tank at once some of them plate spotty and the others even become etched in spots. Can you tell me what my trouble is?

P. P. C.

Answer: Your trouble seems to be either too little current for the larger tank load, or insufficient number of silver anodes in the tank. When the number of parts in the tank is increased, you must increase the total current flowing through the bath proportionately to maintain a given cathode current density. You should also be sure that you have enough silver anodes in the tank to give about the same total surface area as the parts being plated.

Soft and Hard Nickel Deposits

Question: Can you offer any suggestions for hardening and softening the deposit of a standard cold, still dull white nickel solution?

W. K. S.

Answer: Softer deposits are obtained from the cold white nickel bath when the bath is operated in the lower pH range (3.5-4.5). Harder deposits are obtained at a higher pH. Temperature also has an effect, warm baths favoring the production of softer deposits.

Chemical Anodizing of Aluminum

Question: We are interested in producing a finish on aluminum similar to the "Alumilite" finish, but do not wish to invest in the large amount of equipment required for this process. Can you give us a similar process that would not require this high investment?

G. A. D.

Answer: The Alumilite finish is an anodized finish produced in a sulfuric acid bath using high current densities. Many other baths are also in use, but they all require about the same type of equipment. There are, however, several types of finish that can be produced by simple immersion in a suitable bath without electric current. These finishes can also be colored in a similar manner to anodized finishes. A list of firms that can supply these baths is being sent to you. Most of them are patented baths, and licensing arrangements would have to be made with the firms before they could be used.

Silvering Plastics by Spraying

Question: We have heard that silver films can be produced on glass and other non-metallic parts by a spraying process. Can you send us the names of the companies who have this process, and where the equipment may be purchased?

L. V. T.

Answer: Applying silver by spraying methods is widely used in the electroforming industry. A dual-tipped spray gun is used which sprays the solutions of silver and a reducing agent onto the parts, where the silver film forms immediately. A list of firms who make the equipment and can help you set up this process is being sent to you.

Hardware Finishes

Question: Can you tell us how to produce a No. 10 finish on bronze metal? Oxidizing wants to be done without the aid of copper plating.

J. L.

Answer: The No. 10 finish you refer to is evidently the U.S. No. 10 finish which is a standard finish in the hardware trade for bronze. This is a satin finish with a clear lacquer coating. No oxidizing or plating is involved, the finish being obtained by a final satin wheel using an abrasive of about 180 grain size. Standard samples of this and other hardware finishes may be obtained by writing to the U. S. Dept. of Commerce, National Bureau of Standards, Commodity Standards Div., Washington

25, D. C. The cost of a complete set of 18 standards is $4.50.

The oxidized version of this No. 10 finish is known as US10a, and the oxidized and oil rubber version is known as US10b.

Plating Annealed Cast Iron

Question: We seem to have considerable trouble when brass plating annealed cast iron parts, even when we treat them the same way we successfully handle un-annealed parts. Can you tell us why this is?

C. G. J.

Answer: During the annealing process, cast iron undergoes a change in which the carbon present in the cast iron changes over to free graphite. The annealed castings have more of this graphite than the "as cast" parts. It is this graphite that causes difficulties in the plating and cleaning operations, as there are no acids or chemicals that will dissolve it so it can be removed; in fact, etching the metallic portion away in acids merely exposes more of the graphite at the surface. This graphite must be removed mechanically, such as with wire wheels or other abrasive treatment. Barrel burnishing is frequently used to condition cast iron parts for plating, as this operation has a tendency to smear the graphite over the surface of the parts in a thin film which can then be removed in an electrocleaning operation.

Annealing the castings in mill scale has been tried for some types of parts This treatment removes the carbon (decarburizes) the surface for a depth of several thousandths or more, leaving a substantially carbon-free surface which is easier to plate upon. If much stock is removed by polishing, however, this depth of carbon-free iron may not be deep enough.

Flashing the brass on at a high current density for the first ½ minute or so has also been successful in some cases. This is then followed by plating at the usual current density for the balance of the plating period. Copper plating is sometimes used before brass on cast iron, but this should ordinarily not be necessary.

Silver Plating Zinc Die-Castings

Question: We have a problem in silver plating zinc die castings, in that the metal seems to turn black and begins to build up with silver particles and comes out very rough. Other parts made of various metals in the same tank load seem to plate all right. We have even tried a light flash of copper on the zinc parts, but that does not seem to help. Can you help us to solve this problem?

J. R.

Answer: You are probably getting an immersion plate on the zinc parts when they are placed in the silver strike tank. This can happen even with a very light copper flash, for unless electrical contact is made immediately as the parts are immersed in the silver strike bath, the high free cyanide content of the bath will dissolve the thin film of copper from the parts. Try using a heavier copper plate, and make sure that contact with the cathode rod is established at once after the pieces are placed in the silver strike.

Bright Silver Plated Ornamental Work

Question: Recently I have seen some silver plated work which was bright finished even down into rather small recesses. I am sure that these surfaces could not have been buffed. Can you tell me how this might have been done?

F. J. N.

Answer: There are several possible ways that the bright silver is produced in the recesses of plated articles. The first, of course, is that the bright plating may have been done in the tank. While the commercial plating baths for silver do not yield a plate that compares in appearance to a buffed silver, some newer installations have been successful in obtaining a fairly bright deposit directly from the bath. A stronger possibility is that the parts you saw were electropolished after silver plating. This process makes it possible to brighten up surfaces that might otherwise not be reached by a buffing operation. Details of this electropolishing method for silver were contained in the May 1947 issue of *Metal Finishing*.

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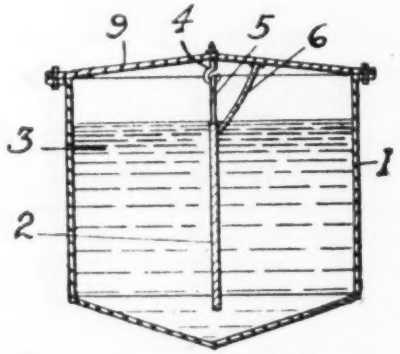
Patents

Galvanic Coating Process

U. S. Patent 2,444,174. *Allan L. Tarr and George W. Oxley and Frank C. Fyke, assignors to Standard Oil Development Co.*

The process of forming a protective coating on ferrous metals in contact

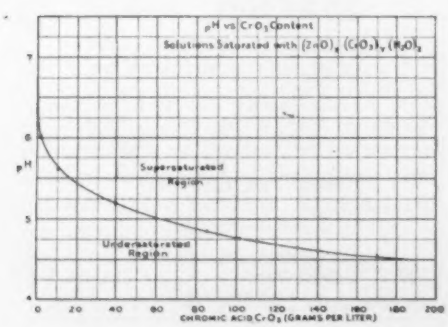


with seawater which consists of the steps of contacting the said ferrous metals to seawater, positioning in the seawater a sheet of wrought zinc having an effective surface of about 2% of the ferrous surface to be protected, and electrically connecting said zinc sheet to said ferrous surface, whereby, the galvanic action developed causes deposition on the ferrous surface of a firm dense protective coating consisting of inorganic salts of zinc, magnesium and calcium.

Protection of Cupriferous Surfaces

U. S. Patent 2,445,155. *Albert J. Saukaitis, assignor to American Chemical Paint Co.*

A process for increasing the resistance of cupriferous surfaces to corrosive influences, which process comprises the steps of treating a cupriferous surface with an aqueous zinc chromate

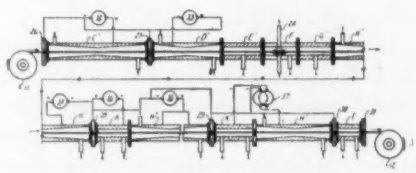


solution, rinsing the surface with water, and treating it with a dilute zinc chromate solution, the solutions being formed by dissolving in water chromic acid and a zinciferous component consisting of at least one of the group zinc oxide, zinc hydroxide, and zinc carbonate; the proportion of total dissolved chromic acid in the solution first mentioned being from 8.5 to 175 grams per liter, and the proportion of total dissolved chromic acid in the solution last mentioned being from 0.075 to 15 grams per liter, and at least one of the solutions being saturated as respects the zinc chromate phase in equilibrium therewith; said process further being characterized in that the cupriferous surface is dried by evaporation following treatment with a saturated solution.

Apparatus for Producing Coated Wire by Continuous Process

U. S. Patent 2,445,675. *William C. Lang.*

Apparatus for coating wire by continuous process comprising an electrically-conducting fluid-containing cylindrical treating chamber of varying

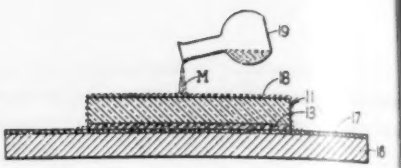


inside diameter, electrically conducting drawing dies at the ends of the chamber, but insulated from the chamber, and an electric current supply means for supplying current to said chamber and to said dies, the wire to be treated passing through said dies and said chamber on the line of axis of said chamber, the walls of said chamber being of larger diameter at the ends and uniformly tapering to an intermediate smaller diameter at the center of the chamber so as to maintain uniform current density on the wire in its travel throughout the length of said chamber.

Method of Producing Mirrors By Chemical Deposition

U. S. Patent 2,445,253. *Frank H. Verhoek and Willard L. Morgan, assignors to Libbey-Owens-Ford Glass Co.*

The method of making mirrors by chemical deposition of an alkaline mirroring solution upon one surface

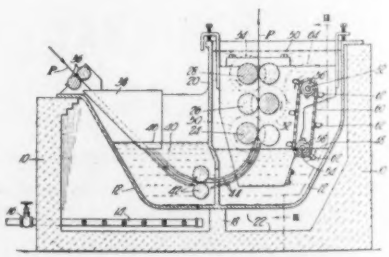


of a sheet-like support, which comprises substantially completely contacting one surface of the support with a water-wet gelatinous coating so as to protect said surface from contact with said alkaline mirroring solution to be applied to the other surface of the support, said gelatinous coating consisting of gelatinous water-insoluble inorganic metallic compound material and a sufficient amount of water to form a stiff non-flowable gel that closely adheres to said surface, said coating being insoluble in said alkaline mirroring solution and being sufficiently stiff to prevent displacement by any of such solution which might reach it after being applied to said other support surface, and then applying to said other support surface, while the gelatinous coating is still on said first support surface and is still wet, said alkaline mirroring solution and depositing a mirror deposit upon such other surface.

Apparatus for Coating Metal Sheets

U. S. Patent 2,446,697. *Frank E. Fairley, Louis T. Lindquist, Clyde D. Michaels and Howard C. Rodgers, assignors to Tennessee Coal, Iron and Railroad Co.*

Metal-coating apparatus comprising a vessel adapted to contain a bath of molten coating metal covered by a



body of oil, a bucket conveyor mounted within said vessel and having one portion extending below the normal level of the metal bath and another portion extending into the body of oil, said conveyor being adapted to discharge small quantities of molten metal successively into the oil so as to effect an exchange of heat from the molten metal to different regions of the oil.

Cowles

FAST ACTING
EMULSION SOLVENT CLEANER

LIXOL

LIXOL works faster because of its multiple penetrant formulation and good rinsing properties. It produces emulsions that are stable in the face of extreme soil, temperature and water conditions—preventing soil redeposition.

LIXOL is designed for still tank, pre-soak and washing machine equipment. No cleaner of this type works as well in all three because:—

★ LIXOL Penetrates
★ LIXOL Rinses Easily
★ LIXOL Cleans Thoroughly
★ LIXOL Is Stable
★ LIXOL Prevents Rust

Cowles
TECHNICAL SERVICE
ON REQUEST

Prompt shipments from local stocks.

Cowles Chemical Company

FORMERLY THE COWLES DETERGENT COMPANY

METAL CLEANER DEPARTMENT • CLEVELAND 3, OHIO

Process of Electroplating on Tungsten

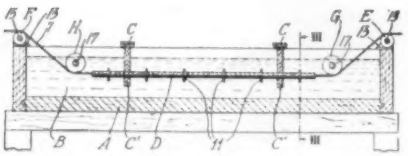
U. S. Patent 2,443,651. *Joseph J. Cannizzaro, assignor to Westinghouse Electric Corp.*

In the process of electroplating a metal on a tungsten member, the steps comprising applying to the tungsten member a hydrofluoric acid solution, passing an alternating current at 5 volts through the tungsten member in the presence of the hydrofluoric acid solution for from one to two minutes to etch the surface, removing the etched tungsten member from the hydrofluoric acid solution and electroplating a metal on the treated tungsten member.

Process of Copper Coating Stainless Steel

U. S. Patent 2,445,372. *Herbert W. Trenbath, assignor to The American Steel and Wire Co. of N. J.*

The process of electrochemically



coating stainless steel wire with copper without externally applied electric current, which comprises moving the stainless steel wire through an aqueous solution of copper sulphate as electrolyte and maintaining the wire while immersed in said solution in contact with plain carbon steel bodies, the stainless steel wire and plain carbon steel bodies being in direct contact with each other at spaced apart points within said solution, thereby forming a galvanic couple between the stainless steel wire and the plain carbon steel bodies, said contact being maintained until said wire is coated with copper from the electrolyte.

Electrodeposition of Aluminum

U. S. Patent 2,446,349. *Thomas P. Wier, Jr. and Frank H. Hurley, assignors to The William Marsh Rice Institute.*

A process of electroplating that comprises electrodepositing aluminum as a bright, adherent deposit on a metal from the group consisting of iron, copper, brass, bronze, lead, and nickel and tin from a cell containing a liquid nonaqueous electrolyte consisting essentially of a mixture of (1) about 2 mols of aluminum chloride, (2) about 1 mol of ethyl pyridinium chloride, and (3) a sufficient amount of toluene to saturate the mixture.

Electrodeposition of Aluminum

U. S. Patent 2,446,350. *Thomas P. Wier, Jr., assignor to The William Marsh Rice Institute.*

In a process of electroplating with aluminum the step of subjecting an article of a metal from the group consisting of brass, copper and iron, serving as a cathode, simultaneously to an alternating current and a direct current, passed between said cathode and an aluminum anode and through a fused, anhydrous bath consisting of (1) about two mols of aluminum chloride and (2) about one mol of ethyl pyridinium chloride, to plate aluminum onto said article; the root mean square value of the alternating current being about two to three times the value of the direct current.

Method of Forming Silver Sulfide Coatings

U. S. Patent 2,445,962. *Clifford W. Mell, assignor to Radio Corp of America.*

The method of forming a coating of silver sulphide on a silver surface which comprises first treating said silver surface with a film-forming hydrophilic substance, then drying said treated surface, and then exposing said treated surfact to a humid atmosphere saturated with hydrogen sulphide and containing from about 90 percent to about 100 percent humidity until a desired coating of silver sulphide has formed on said treated surface.

Process for Metallizing Nonmetallic Articles

U. S. Patent 2,447,380. *Frederick Ross Wenger, assignor to Focal Company.*

The process of undercoating nonmetallic articles for plating that comprises mixing a solution consisting of about 1 g. silver nitrate to 1 cc. water with an alcoholic-acetone mixture, containing between 20 and 50% alcohol, in a proportion yielding from about 10% to about 15% silver nitrate, immersing a said article therein for about one-half minute at room temperature, semi-drying the article, and immersing the article in a solution consisting of 5-10% sodium hydrosulfite in distilled water.

Electrodeposition of Aluminum

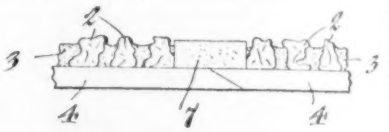
U. S. Patent 2,446,331. *Frank H. Hurley, assignor to The William Marsh Rice Institute.*

A process of electroplating that comprises electrodepositing aluminum as a bright, adherent deposit on a metal from the group consisting of iron, copper, brass, bronze, lead and tin from a cell containing a liquid nonaqueous electrolyte consisting essentially of a fused mixture of (1) about 2 mols of aluminum chloride and (2) 1 mol of ethyl pyridinium chloride.

Joint for Abrasive Belts or Bands

U. S. Patent 2,445,807. *William B. Summers and William A. Corse, assignors to The Carborundum Co.*

In a method of making an abrasive belt the steps which comprise providing a strip of abrasive coated sheet material comprising a backing and a layer of abrasive grains attached to one side thereof by an adhesive, removing



the abrasive grains from each end of the strip over an area which is substantially the same, applying an adhesive to one of the said areas, overlapping the ends of the strip, applying a finely divided lubricant and a liquid which is convertible to a hard tough solid to that portion of the outer surface of the article which is substantially devoid of abrasive grains, and hardening the cement and the said liquid.

Zinc Plating Process and Electrolyte

U. S. Patent 2,446,983. *Alvin Frederick Prust, assignor to Republic Steel Corp.*

An aqueous zinc plating electrolyte containing, per gallon thereof, from 10 ounces to 20 ounces of zinc chloride, from 10 ounces to 20 ounces of sodium chloride, from .15 ounce to 1.0 ounce of fluorine in the form of an alkali salt, and about 0.2 ounce of chloride of a metal selected from the group consisting of alkaline earth metals and aluminum, said electrolyte having a pH value of from 4.8 to 5.4.

Engineering Information Useful In Designating Metallic Surface Treatments

Engineering Data Sheet

Thickness Testing of Electroplated Coatings

METHOD	PRINCIPLE	ADVANTAGES	DISADVANTAGES	REMARKS
Microscopic	A carefully prepared cross section of the plated part is examined under a magnification of 100-500 diameters. Thickness is read directly through the use of a micrometer eyepiece.	1. High degree of accuracy. 2. Direct reading of thickness.	1. Destructive of both the coating and the specimen. 2. High preparation costs. 3. Skilled operator required.	Gives extremely localized readings and care must be taken to select representative areas when cutting cross section. Used as a standard to check accuracy of other methods.
Mesle's Chord	Involves cutting through the coating on a curved surface with a flat file or on a plane surface with a precision grinding wheel of known radius.	1. Simplicity of operation and equipment. 2. Rapid determination. 3. Highly accurate on the harder metal coatings.	1. Destroys the coating. 2. Not accurate for coatings under 0.0002". 3. May be inaccurate on soft deposits such as zinc, due to "smearing".	Thickness is computed according to the formula $T = C^2/8R$, where "C" is the chord (width of the cut where the base metal is just exposed), and "R" is the radius of the grinding wheel or the curvature of the surface tested.
Magnetic	Measures the current necessary to detach a magnetized needle or the force necessary to pull a magnet from a plated surface.	1. Non-destructive. 2. Completely portable. 3. Simple to operate. 4. Relatively high accuracy for deposits heavier than 0.0002".	1. Readings are not direct; they must be converted to thicknesses by reference to a calibration curve supplied with each instrument. 2. Not suitable for non-magnetic coatings on non-magnetic bases.	Although not as reliable as the microscopic method, the simplicity, low cost and speed of the magnetic method, particularly the type which measures the force required to pull a magnet from the surface, has resulted in its high popularity. The instrument is adaptable for measuring the thickness of non-magnetic coatings on a magnetic base and nickel coatings on either a non-magnetic or a magnetic base.
Chemical	Deposit is stripped completely from a known area and the average thickness is computed from the determined weight of the coatings or from the time required to effect removal.	1. Economical. 2. Relatively rapid.	1. Accurate preparation and control of solutions is required. 2. Accuracy relatively low. 3. Destroys specimen.	Average thickness is computed by measuring weight of deposit over a given area; local thickness is computed by calibrating time to remove coating from a small fixed area. Spot tests, dropping tests and jet tests are all used. Relative accuracy of these methods is low.
Electrochemical	Involves measuring the time required for a coating to dissolve anodically at a specific current.	1. Very accurate. 2. Rapid determination.	1. Requires close controls. 2. Destroys coatings.	Electrochemical methods give a high order of accuracy but require close control to assure uniform current density. A recent development has resulted in a completely automatic machine which gives direct thickness readings. Controls are provided to assure uniform results.

Recent Developments

New Methods, Materials and Equipment for the Metal Finishing Industries

Automatic Abrasive Belt Polisher and Grinder for Flat Stock

Curtis Mach. Corp., Dept. MF, Jamestown, N. Y.

Rugged welded steel frame to eliminate vibration. Straight through arrangement for high speed production. Allows feeding manually, by coil unwinding and winding machines or by conveyor or equivalent means. Abrasive belt widths up to 10″ available. Infinitely variable feed from 20 to 60 feet per minute, quickly adjustable. Screw adjusted feed rolls take stock of any thickness up to 1″. Fast, accurate contact grinding principle. Price, F.O.B. Jamestown, complete with dust guards and 3 HP, 220/440 volt, 60 cycle AC motor, $2,500.

The Curtis Straight-O-Matic Model 600 is a completely new addition to a famous line of abrasive belt type sanding and grinding machines and was designed for automatic finishing of flat stock.

This machine is rigidly built in three subassemblies; namely, the base, sanding unit, and feed mechanism. Any one or all of these units may be purchased, thus enabling a manufacturer to set up for line production or batch production according to his individual requirements. It can be used as an individual machine, changing belts for the various grits to be used or can be used in tandem. Can also be supplied with an inverted head so that both top and bottom can be finished with one pass of the stock.

The abrasive belt drive motor, belt tension and micrometer tracking devices are all conveniently arranged for quick belt changing and alignment.

Specifications on the machine are as follows:

Machine size: Width 24″, depth 42″, height 91¾″, work height 38″.

Standard electrical equipment: Sand belt motor: 3, 5 or 7½ HP @ 1200 RPM; 3 phase, 220/440 volt, 60 cy. A.C.

Feed motor: ⅓ HP, 220/440 volt, 60 cy. A.C.

Magnetic switches and push button controls.

Contact roll: 4″ dia. rubber covered. Double row shielded high grade ball bearings.

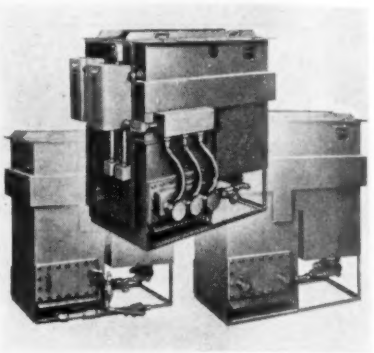
Abrasive belt specifications: Width up to 10″, length 111″ belt speed with 1200 RPM motor—5140 ft/min.

Hand-Operated Degreaser With Quick-Conversion Heating

Detrex Corp., Dept. MF, Detroit 32, Mich.

Announcement of the new "625" Degreaser—a two-dip hand-operated unit designed for rapid, safe and thorough cleaning of medium-size metal parts of all kinds in machine shops, production, assembly, and maintenance departments—has just been made by this firm.

This unit can be heated by steam, gas or electricity, whichever is most practical at the particular time and location. It can also be furnished for combined gas-and-steam or gas-and-electrc heating. A most important and unique feature of this new design of equipment is the standardization of main body construction so that it can be quickly converted from one type of heating to another where seasonal changes in heating method give added economy, or convenience.



The Detrex "625" Degreaser employs the immersion-solvent-vapor degreasing process originated by Detrex some years ago and used in many thousands of manufacturing plants where rapid, low-cost cleaning is the goal. It removes grease, oil and similar materials many times faster than other methods, and leaves all surfaces, external and internal, thoroughly clean and dry, it is claimed. To operate, the parts are simply lowered into boiling solvent, transferred within the machine to a cool solvent rinse compartment, and after a few seconds, they are removed through the solvent vapor zone. The solvent used is non-flammable, and cannot burn or explode.

This new degreaser is of all-welded construction, fabricated from 10-gauge steel plate and reinforced with structural steel. All interior surfaces are protected with a zinc coating which is sprayed on after fabrication. There are no moving parts to wear or get out of adjustment; cleaning costs are very low; and further economy is

provided by the quick change of heating method, if required.

Production capacity is conservatively rated at 1000 lbs. of steel parts per hour. This unit will immersion-clean parts that will go into a space 18 in. by 21 in. by 12 in. deep; and shafts up to 4 ft. in length can be cleaned by suspending them in the vapor zone. Floor space occupied is about 10 sq. ft., and the net weight is approximately 500 lbs.

Contact Wheel for Heavy Grinding

Minnesota Mining & Mfg. Co., Dept. MF, 900 Fauquier Ave., St. Paul 6, Minn.

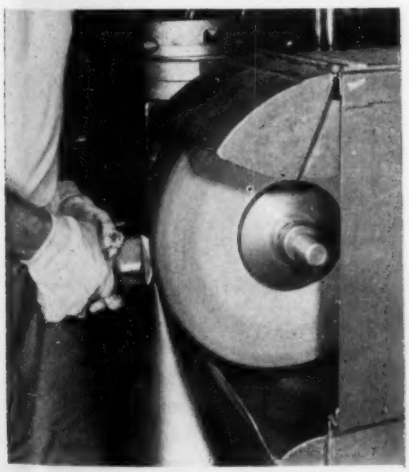
A new contact wheel—the first designed for heavy grinding with abrasive belts at speeds of 10,000 surface feet per minute or more—has been announced by this firm.

Major advantages claimed for belt grinding with the new roll, called the "K" contact wheel, are faster and cooler stock removal, lower production cost, and chatter-free grinding.

It can be used at the maximum speeds of modern equipment, according to its inventor, *Arthur E. Kimball*, the 3M company's manager of development and sales for heavy grinding products.

The combination of the high speed and the new wheel design enables abrasive belts to remove heavy metal stock faster, to perform better-finished snagging, and to eliminate frictional heat problems, it is claimed.

The "K" wheel is made in 8 and 16-inch diameters, in face widths of 2, 3, 4, and 6 inches. It is designed



for use with cloth belts coated with silicon carbide or aluminum oxide mineral grains.

Reduction of grinding heat, accom-

THE NATION STANDS a good chance of slipping on a living room rug and falling flat on its face, if a safety survey of a half-million school children is any indication.

Conducted by the Greater New York Safety Council, the survey gave the youngsters a series of safety situations to check—to see if they were followed in individual homes. Number one hazard, among those listed, was small rugs on slippery floors, not tacked down and not made skidproof.

Last year the survey—one of the largest conducted in the country — showed the ... was improper ... mable materia... line, kerosene a...

Second most ... the children sai... bers of their ... doors and bure... diately after y... surprising nu... ies, the safety...

In third pla... mable liquids ... ing, and in the ... of sturdy bases ... on when reach...

Families w... in leaving ma... small children...

The childre... windows unsc... could fall out... ported a bump... electric cords ... starters.

Explosion ... Down Base...

A heater e... the basement a...

Mrs. Reed ... out of her cha... on the first ... foot of the ... floor. A phy... bruises and sh...

The oil heater ... blast knocke... between the b... and tore the g... hinges. The kit... ripped loose.

The dining ... knocking over ... were called, b... flames.

Jap Croc... First Ti...

Ship manifes... Maritime Exch... the arrival he... ware for the ... war.

The Norwe... brought 30 ca... well as 32 cas... necklaces.

The British ... brought 4,500 cases of sheet rubber from Batavia, Netherlands East Indies.

EXPENDITURES for maintenance and repair of existing buildings are expected to total about $6 billion in 1948, about the same figure as in 1947, according to a forecast prepared by the economists of Producers' Council, David S. Miller, Council president, stated today. The Producers' Council, Inc., is a national organization of manufacturers of building materials and equipment.

"With repair work included, the total volume of all building next year, including new construction, is expected to approximate $20 billion," Mr. Mil... said.

The co... 000 gallon... and used ... said. The ... has been ... the use o... cubic fee... kitchen ra...

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at Inde... featured ...

Emergency squads of police were summoned to handle spectators who

Zorball cleans up local trouble spots

There's one safe, certain answer to the dangerous grease and oil spots you find around machines and on plant floors. It's ***Wyandotte Zorball***, the all-purpose floor absorbent.

Zorball is easy and economical to use. A thin layer of this granular product absorbs oil, grease, water, paints and other liquids quickly and completely. It provides an immediate anti-slip surface underfoot.

Even when saturated, ***Zorball*** retains its original form. There's no caking, packing nor forming of "mud" to be tracked around the shop. It will not injure fabrics, wood, metals, rubber, or the skin of those who handle it.

Furthermore—and this is important—***Zorball*** helps prevent fire hazards. It is chemically inert and nonflammable ... resists combustion even when oil-soaked.

Wyandotte Zorball is listed by Underwriters' Laboratories.

Ask your nearest Wyandotte Representative for complete information on ***Zorball***. All you have to do is give him a call.

Trouble afoot? Why not try WYANDOTTE ZORBALL

Wyandotte
REG. U. S. PAT. OFF.

WYANDOTTE CHEMICALS CORPORATION
WYANDOTTE, MICHIGAN • SERVICE REPRESENTATIVES IN 88 CITIES

plished by the design of the "K" wheel, lengthens belt life in two ways on most heavy stock removal operations, it is said:

1. Loading and glazing of the belt are minimized because the lessened grinding heat fuses fewer metal particles to the mineral grains on the belt, and because the increased centrifugal force of the higher operating speeds throws out more cuttings.

In addition, the bond between the mineral grains and the belt is saved from the ill effects of high frictional heat.

2. High speeds increase the amount of cutting surface which contacts the metal per second, thus allowing less work pressure against the belt, resulting in less belt strain and less operator fatigue.

Portable Electric Disc Grinder

Porter-Cable Machine Co., Dept. MF, 1714 *N. Salina St., Syracuse* 8, *N. Y.*

A powerful 5 in 1 portable electric tool, the D-6, which grinds, polishes, cuts, drills, buffs in metal, wood, glass, ceramics, plastics and other materials has been announced by the above firm.

The basic unit is a 6" disc grinder with attachments to convert it into a polisher, sander, drill, paint mixer, and stone and metal cut-off tool. A drill

chuck takes a ¼" shank for a wide variety of standard attachments.

A stiff 7" disc, infused with silicon carbide grit is used edgewise to cut stone, tile, steel and other hard compositions. Resilient abrasive discs may be used for sanding and polishing, or a buff of lamb's wool may be used for buffing and polishing to brilliant lustre.

The machine weighs less than 6 lbs. and can be quickly transferred to any job, used overhead, vertically, and in cramped space, it is claimed. A guide grip can be attached to either side of the machine for left or right handed operators, or it can be removed entirely for use in limited spaces.

Specifications are: motor, universal 115 volts DC-AC, 25-60 cycle, single phase; spindle, ⅝"—11 thread with ¼" hex socket in end; speed (approximately) 3000 RPM no load, 2000 RPM normal load; overall dimensions, 7⅜" high, 7-9/16" wide, 11⅛" long; net weight, 5 lbs. 13 oz.

Steel Work Bench

Tri-State Metal Products, Inc., Dept. MF, Box 1513, *Pittsburgh* 30, *Pa.*

A heavy duty steel work bench made with 11 gauge prime steel top and 13 gauge prime steel channel type legs, has just been placed on the market by the above firm.

The Tri-State steel work bench is 32" high, 28" wide, and 72" long, and weighs 150 lbs. It is believed to be the heaviest work bench of its kind on the market.

Blast Cleaning Gun

Engineered Products Inc., Dept. MF, 1224 *Speer Blvd., Denver, Colo.*

The Tornado Combination Blast Gun is a versatile adaptation of sand blasting and solvent spraying. Tornado improves and simplifies surfacing, production, cleaning and finishing in automotive and industrial fields. Air operated, portable and efficient, it leaves no buffing marks, no grooves or ridges, no scuffed, gouged or uneven surfaces, it is claimed.

Tornado is particularly useful in reaching inaccessible places such as wheels, drip mouldings, grill work, brick and rough finished walls, rungs, spoolings, steam radiators, fins, odd shapes, corners, crevices and close fittings. Users have reported increased production, lower labor costs, better work, cleaner jobs, improved methods and better finishes than competition can produce, according to the manufacturer.

The gun is connected to any air line and is equipped for sand blast operations or spraying solvents and liquids. The nozzle is easily changed by loosening a retaining nut and slipping another nozzle in place.

The gun balances perfectly in the hand, is light to handle and easy to use. Simply point the gun at the surface to be prepared and pull the trigger. Paint melts away, rust, scale and oxidation disintegrate. Solvents penetrate to flush out grease, gum and tar. Oils and liquids penetrate where needed.

Two attachments are supplied with the Tornado Gun an "Abrading" case-hardened nozzle for use in blast operations and a "Solvent" nozzle for use with oils or chemicals. The abrading nozzle incorporates a "safety" tip that drops off when barrel needs replacement.

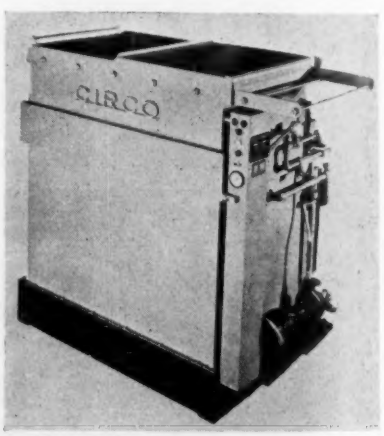
Tornado is equipped with a 3 pint container designed for quick, sure locking with a quarter turn. No threads to sand-strip or jam. The turbulence shield is designed to stop and retain the bulk of spent abrasive that ricochets from surface being worked. All parts are precision machined and factory tested. Packaged shipping weight is 4½ pounds. Maximum air consumption is 9½ cubic feet per minute at 100 to 150 pounds pressure.

Stainless Steel Degreasers

Circo Products Co., Dept. MF, 12117 *Berea Rd., Cleveland* 1, *O.*

The above firm has announced their new push-button controlled vapor degreasers, in which all surfaces exposed to solvent vapors are protected by stainless steel.

In addition to the stainless steel pro-



tection and automatic, fool-proof operating controls, these Circo degreasers feature:

1) A built-in reservoir tank for liquid solvent flushing and for automatically restoring solvent to proper operating level in tank, as well as conserving valuable shop space.

2) Large, readily removable, leak-proof clean-out door, which makes cleaning of tank easier and quicker.

3) Elimination of moving parts, to assure trouble-free operation at lowest possible maintenance costs.

4) Push-button controls have indicating lights which, with a temperature gauge, constantly show operating condition of degreaser—thus assuring continually economical performance.

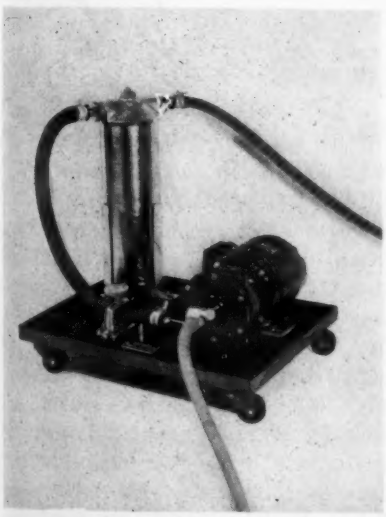
5) 20% increase in work capacity and speed of efficient and thorough cleaning of parts.

Small Portable Filtering Unit

Sethco, Dept. MF, 105-07 150*th Street, Jamaica* 4, *N. Y.*

The above firm announces another small filter unit, Model SSI. This model is similar to their previously announced unit, Model SSU. However, Model SSI is equipped with a totally enclosed ball-bearing induction motor. The totally enclosed feature prevents corrosion of motor components where accidental spilling of solutions is likely to occur. The ball-bearing feature results in smooth operation and longer life, and no oiling is required.

Like Model SSU, Model SSI is designed for either periodic or continuous filtration. This unit is also con-



structed of stainless steel throughout and is admirably suited for filtering all the common plating baths.

These filter units are extremely simple and economical to operate. Only 3 minutes are required to set them up and approximately 20,000 gallons of solution with average impurities can be filtered through each filter tube before it needs changing. These units have definite advantages for filtering expensive solutions such as silver, gold, rhodium, since all the solution

CUT BARREL DESCALING TIME UP TO 90% WITH MAGNUS D-SCALE-R

OPERATION

The operation is usually carried out in an open barrel, using 4-16 oz. of D-Scale-R per gal. of water, depending on the amount of scale or rust. Most scale can be removed in 15-30 minutes. Parts are usually examined at 5-10 minute intervals to observe the progress of descaling. When scale is all off, cold water is run into the barrel to overflowing, the solution is dumped and an alkaline cleaner (approximately 2 lbs. to a barrel) is added with water to fill, and the barrel run 5 minutes as a security measure to neutralize any remaining traces of D-Scale-R.

Write for complete information.

Save on Rejects, too!

Removal of heat treating scale and rust from steel parts by tumbling is a common enough practice, but often this operation is a costly bottleneck because of the time involved and the rejects due to the removal of too much metal.

Magnus D-Scale-R is an inhibited acid liquid cleaner widely used for descaling in barrels. It quickly attacks and dissolves rust and scale, but will not attack metals in the normal periods in which it is in contact with them.

Where descaling in tumbling barrels takes many hours, D-Scale-R usually does a better job in 15-30 minutes. In most cases, no stone chips or abrasives are needed eliminating the main cause of excessive removal of metal.

MAGNUS CHEMICAL COMPANY • 11 South Ave., Garwood, N. J.

In Canada—Magnus Chemicals, Ltd., 4040 Rue Masson, Montreal 36, Que.

Service representatives in principal cities

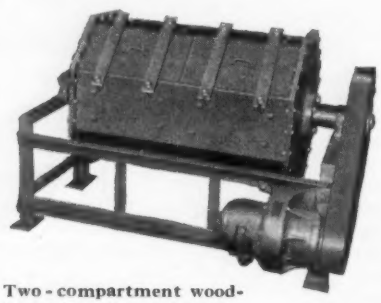
IN METAL CLEANING IT'S **Magnus**

CLEANERS • EQUIPMENT • METHODS

A TUMBLING BARREL FOR EVERY PURPOSE

Yes . . . Henderson can supply you with tumbling equipment in a variety of sizes, shapes and materials for practically every tumbling requirement. Nearly three quarters of a century in designing and manufacturing tumbling barrels for the GRINDING, BURNISHING, POLISHING and CLEANING of metal stampings, balls, bearing races, forgings, small castings, screw machine products, jewelry, wire forms and small metal parts. Tilting type barrels of Steel, Wood or Alloy Metal . . . Horizontal type barrels of Cast Iron or Cast Steel. Wood or rubber lined in all Models. Also special barrels for plastics.

#5A Motor Driven Tilting Oblique Tumbling Barrel.



Two-compartment wood-lined Burnishing Barrel.

If your requirements call for faster production and finer quality at lower cost or if you require Tumbling Barrels of special design, our Development and Engineering Service will be glad to make recommendations.

Write for further information.

Since 1880 - Designers and Builders of Tumbling Barrel Equipment

THE HENDERSON BROS. COMPANY
135 SOUTH LEONARD ST. WATERBURY 85, CONN.

contained in the unit is completely recoverable.

The removal of organic matter, grease and oil from solutions is a simple, clean and efficient procedure: no filter aid is necessary, no messy powdered charcoal, no slurry tank, and no waiting for clear effluents, it is claimed.

Since the units weigh only 30 to 40 pounds (depending on the model), they are easily portable.

Silver Cyanide

American Platinum Works, Dept. MF, 231 New Jersey R.R. Ave., Newark, 5, N. J.

The above firm announces that it is now in a position to supply silver cyanide of high purity and solubility for all silver electroplating baths. Large stocks insure immediate delivery. High purity silver anodes are also available from this firm, which has been a leader in the precious metals field for over 70 years.

Powdered Hand Cleaner

Magnus Chemical Co., Inc., Dept. MF-I, Garwood, New Jersey.

The above firm, manufacturers of industrial cleaning materials and machines, now offers its powdered hand cleaner in attractive, handy five-pound containers for easy dispensing.

The new package is designed for industrial plants and others having wall-mounted powdered hand cleaner dispensing units in their washrooms. The dispensers can be refilled direct from the new package as it is of an easy-to-carry size and is provided with a pouring spout. It eliminates the waste of time and material in transferring the hand cleaner from a bulk container to the receptacle used for servicing the dispensers. It also provides better stock control of the hand cleaner.

The containers are packed in cartons of eight units in the following grades:

Heavy Duty—for cleaning unusually dirty hands.

Medium (most widely used grade)—for general use in most industrial plants and garages.

Superfine—for office workers.

Magnus Hand Cleaner is also sold in eight ounce cans and in bulk containers of 115 and 250 pounds.

The only scouring agent used in these cleaners is a very high grade of pure pumice containing no hard quartz crystals or sharp jagged edges to abrade the skin, according to the manufacturer. All particles are soft and porous enough to wear or break down during normal rubbing without scratching the skin. It cleans equally as well with hot or cold water, it is claimed.

Preventing Staining After Plating

Lea Mfg. Co., Inc., Dept. MF, 16 Cherry Ave., Waterbury 86, Conn.

The above firm, manufacturers of finishing and plating supplies, has introduced LEAtardent, a protecting solution recently perfected in its laboratory. LEAtardent is used in the plating shop to prevent water staining and tarnishing of nickel plated work, brass work and, to some extent, copper, prior to operations such as lacquering, packing, plating, assembly, etc. A particularly useful advantage is that when once treated by LEAtardent the article can be kept around for a few days until ready for lacquering without danger of tarnishing, it is claimed. Ordinarily such work upon standing must be re-cleaned and dried prior to lacquering.

LEAtardent is a liquid of about the color and consistency of milk. It is used either full strength or diluted up to 3 parts of water as a final dip on the work. It is used cold, although after being dipped in LEAtardent, the work can be rinsed in either cold or hot water (up to 200° F). However,

where there has been dilution up to 2 or 3 parts water, a final water rinse is optional. For air drying, whether in a centrifuge or on a sawdust table, the temperature should not exceed 140° F. The material comes in 5 gal. cans and 50 gal. drums.

Additions to H-VW-M Cleaner Line

The Hanson-Van Winkle-Munning Company, Dept. MF, Matawan, N. J.

The above has developed a new group of modern efficient cleaners. In addition to the Matawan 45 and 65 series announced several months ago, they now offer six new Matawan numbers, each selected to meet a demand not fully satisfied before.

Matawan No. 20-W is a mild non-etching cleaner containing a synthetic wetting agent and a water softener. It is primarily a soak cleaner for aluminum, and will not etch the surface, it is claimed. It is also used for cleaning zinc base die castings and brass. Both applications employ Matawan No. 20-W as a soak or cathodic cleaner.

Matawan No. 20-X is a mild non-etching alkaline cleaner containing a cresylic base which aids in the stripping of paint and heavy oil films from aluminum. It is used as a paint stripper on aluminum or an extra heavy soak cleaner on very soiled aluminum parts.

Matawan No. 25 is a non-silicated medium caustic base especially designed for the etching of aluminum where the presence of a silicate would inhibit the desired etching action. It is recommended as a soak solution for etching aluminum. Etching is desired for appearance, for deoxidizing and lowering of surface resistance preparatory to spot welding and as preparation for better adherence of anodic or paint coatings.

Matawan No. 30 is a silicated medium caustic base cleaner containing no foaming or wetting agent. Its application is principally in spray type washing machines for steel parts where its water softening ability tends to keep the machine and jets free of lime scale.

Where the presence of foaming agents in the tank is detrimental to the cleaning process, Matawan No. 30 may also be used as a direct or reverse electro-cleaner.

Matawan No. 30-W is a silicated medium caustic base cleaner containing a

EXOLON

IS THE ABRASIVE

For Fast Metal Polishing

Accurate Grades... Iron Particles Removed

Photomicrograph of Exolon RST Polishing Grains.

Exolon Aluminum Oxide Abrasives are available for polishing all types of metals.

The special production facilities at the new Exolon plant provide unsurpassed uniformity of grading (size and shape) in all standard sizes; thus assuring fast and satisfying polishing results.

Due to its greater freedom from magnetic particles, Exolon is a more efficient grain for polishing stainless metals... a safer material to use since ferrous materials will not become embedded in the surface.

Write for Exolon's folder on polishing procedures and recommendations.

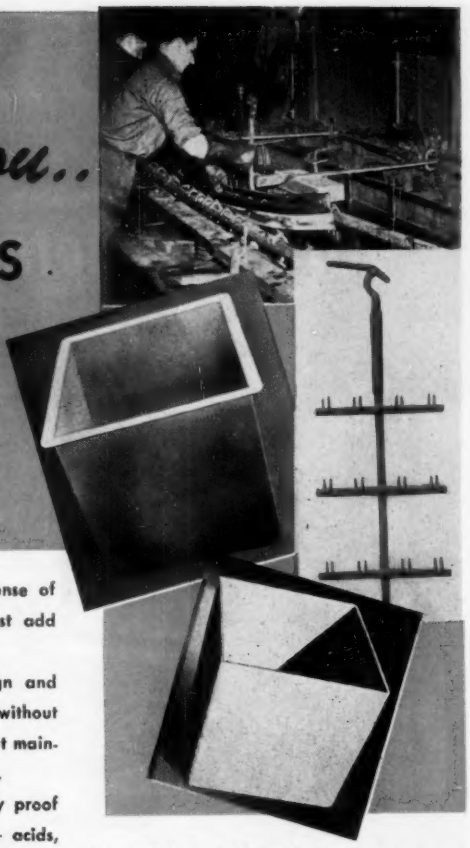
THE EXOLON COMPANY

945 E. Niagara St. Tonawanda, N. Y.

Manufacturers of SILICON CARBIDE and ALUMINUM OXIDE ABRASIVES

What is it Costing You..

to have TANKS and FLOORS that are not acid-proof?



Their cost goes away beyond the expense of keeping them in repair. To that you must add "down time"—time lost to production.

With tanks and floors of Atlas design and construction you can go along for years without "down time" due to corrosion, and without maintenance expense arising from acid attack.

Atlas tanks and floors are permanently proof against — not merely "resistant to" — acids, alkalis, oils and solvents at high temperatures, as well as against hot water and steam.

Your Atlas units will be planned to meet your particular conditions and, with them in service, your corrosion troubles will end — *for good!*

Atlas engineers will study your problem, make recommendations and submit plans and estimates — all without obligation. Contact our nearest branch — or write us at Mertztown for Technical Bulletin T-10-D.

Top tank is steel shell with ZEROK resin lining and 4" of acid-proof brick joined with VITREX, a cement for temperatures to 1600° F.

**Available as a sheet lining applied at our Mertztown plant; also available as a paint, proof against chromic, nitric and other strong acids, and against alkalis.*

Also pictured are other platers' tanks made by us . . . and rack. Tank lining and rack covering is done at Mertztown plant.

Call on us for help with any lining or protective coating problem.

THE Atlas Mineral Products Company of Penna.

THE ATLAS MINERAL PRODUCTS CO. OF TEXAS INC., Box 252, Houston 1, Tex.

*BERKELEY 2, Calif., 605 Addison St.
DALLAS 5, Tex., 3921 Purdue St.
*DENVER 2, Colo., 1921 Blake St.
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*CHICAGO 1, Ill., 333 No. Michigan Ave.
*DETROIT 2, Mich., 2970 W. Grand Blvd.
NEW YORK 16, N. Y., 280 Madison Ave.

PENNSYLVANIA
PITTSBURGH 27, Pa., 4921 Plymouth Rd.
PHILADELPHIA, Pa., 355 Fairview Rd. Springfield, Pa.
ST. LOUIS 5, Mo., 7603 Forsythe Blv'd.

IN CANADA: Atlas Products are manufactured by H. L. BLACHFORD, Limited, 977 Aqueduct Street, Montreal 3, P. Q., 86 Bloor St. W., Toronto, Ont.

suitable wetting agent. It is ideal for the job shop operator because it can be used on iron, steel, brass, or bronze as a soak or as an electro-cleaner, anodically or cathodically, it is claimed. It may also be used as an anodic die cast cleaner.

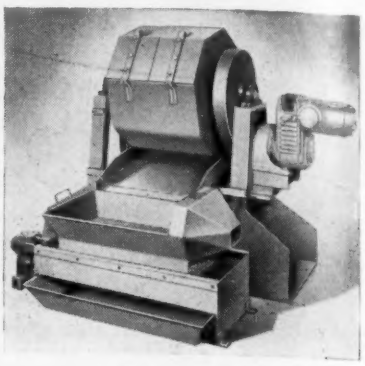
Matawan No. 50-W is a non-silicated high caustic content type cleaner containing a wetting agent. The main usage is as a soak solution for the cleaning of magnesium. Matawan No. 50-W is particularly adaptable for this purpose prior to the H-VW-M Manodyz process.

In addition to the above, H-VW-M has available the Matawan 45 series; 45, 45-W, and 45-F. They contain no free caustic, but rather a combined form of caustic which is more effective in its action on soil, has longer tank life and resistance to breakdown, according to the manufacturer. They are designed for medium to heavy duty cleaning of steel and iron.

Deburring and Separating Barrel

Belke Mfg. Co., Dept. MF, 947 N. Cicero Ave., Chicago 51, Ill.

Savings of time, labor and floor



space are afforded by the Belke combination deburring barrel and separator, developed by the above firm.

In the barrel, burrs are removed from machined parts without affecting close tolerances, it is claimed. The uniform finish produced is ideal for painting and many types of electroplating—also as preparation prior to burnishing. The barrel has two compartments permitting two completely independent jobs to be run simultaneously. 1, 3 or 4 compartment barrels are also available.

The barrel is rotated by an enclosed variable speed drive. Adjustment to any rotating speed between 13 and 39 RPM is made by merely turning the hand crank. Any speed ranges based on a 1 to 3 or a 1 to 4 ratio can also be furnished.

As the barrel is emptied, the load slides down the chute into the motor-driven separator which separates the work and media. The hopper, which tilts for convenient emptying, and the removable drawer below, provide easy handling of the separated media and work.

The separating screen in the bottom of the hopper is mounted on an easily removable wood frame. The wood frame prevents the work from hitting the steel sides of the hopper as it oscillates. Screens are furnished with mesh sizes and shapes to specifications.

Complete information mailed promptly on request to the manufacturer.

Business Items

George A. Meyers Joins F. B. Stevens, Inc., Sales Force

Frederic B. Stevens, Inc., Larned and Third Sts., Detroit, Mich., announce the appointment to their sales organization in the metropolitan area, of *George A. Meyers*.

George, or "Hungry," as he is more intimately known among Detroit Purchasing Agents, is a bona-fide native Detroiter. He was born and raised in the Motor City.

He was formerly purchasing agent for a well known screw machine products company, but entered the selling field in 1933, being engaged principally in the selling of metal finishing products.

He joins the Stevens organization with a background well qualified for the selling and servicing of the Stevens line of buffs and buffing compositions. in which he will specialize.

Handy & Harman Elects New Director

At a recent meeting of the Handy & Harman Board of Directors, *Mr. John W. Colgan*, Sales Manager of the Company, was elected a Director. Mr. Colgan first served the Company at the Home Office in New York in various capacities in the Sales Department. In 1935 when the company opened a new plant in Toronto he became manager in charge of all production and sales activities. During the next six years, under his guidance, this subsidiary, *Handy & Harman of Canada, Limited*, became firmly established and in 1941 he was called back by the parent company to take over the duties of Sales Manager. He has been with the company for the past 29 years.

John W. Colgan

Why Pay Extra?

Have You Tested

BUNATOL No. 1000

Rack Insulation?

If not, send us one of your racks and we will insulate it—with No. 1000 (no charge), so an actual test can be made. Then compare results and prices. No need to pay an extra price for a long life insulation when BUNATOL is available. Have the best in quality at our low price.

Remember, No. 1000 is 100% solids. No evaporation—no loss. Just a prime, a dip and bake, all in about two hours. Saves labor and time. Cost is negligible compared to results.

Send a rack today and find out about this low cost insulation. Test and compare prices.

NELSON J. QUINN COMPANY

Toledo 7, Ohio

BUNATOL

Cowles Chemical Company Offers Common Stock Issue

Cowles Chemical Company, Cleveland, Ohio, a closely held company since its founding in 1885, recently offered to the public 6,965 shares of common stock through a syndicate of four Cleveland underwriters. The underwriters reported that the entire issue was sold within forty-eight hours of the initial announcement of sale.

In a letter to stockholders, *Mr. Edwin Cowles*, President of the Company, explained that this financing will provide the firm with additional working capital to make possible needed additions to productive equipment and to strengthen the cash position of the company.

Washington, D. C., Class for Electroplaters

The class will meet in the lecture room (Room 214) of the Chemistry Building of the *National Bureau of Standards*, for 32 weeks, from 7 to 10 P. M., on each Wednesday beginning September 29, 1948. Usually one half of the period will be devoted to a lecture and discussion, and the

Filter All Plating Solutions Faster, More Completely in

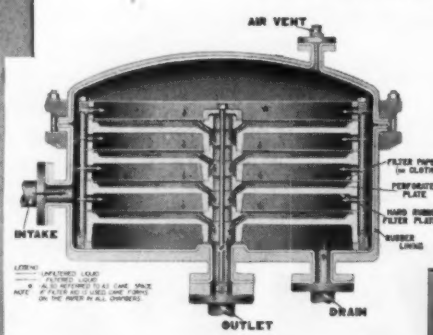
SPARKLER *Horizontal Plate* FILTERS

Because the filter cake is held horizontally, it is absolutely stable to the end of each filtering cycle. And cycles are longer because the cake retains its porosity longer. That is why the "horizontal principle," as embodied in Sparkler filters, gives you more efficient, low cost, operation. Sparkler filters are pressure-tight and leak-proof, designed for intermittent or continuous operation.

4 Plating Solution Types

1. Rubber-lined for bright nickel
2. Stainless steel for acids
3. All Iron for alkaline solutions
4. All Steel (with Stainless Pump) for chromium

SPARKLER MANUFACTURING CO.
Mundelein, Illinois



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60 to 10,000 G.P.H.

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Our Engineering Service is available for any specialized problems.

other half to laboratory experiments.

The general outline of the course is as follows:

1. Elementary Chemistry.
2. Electricity and Electrochemistry.
3. Analysis of Plating Solutions.
4. Testing of Deposits.

The fee for this course will be $10 per term of 16 weeks, payable by the second meeting of each term.

Those interested in the class may come to the first period, without obligation, but will be expected to register in the second period for that 16 week term if they desire to continue.

The chairman of the committee in charge is *Dr. W. Blum*, of The Bureau of Standards.

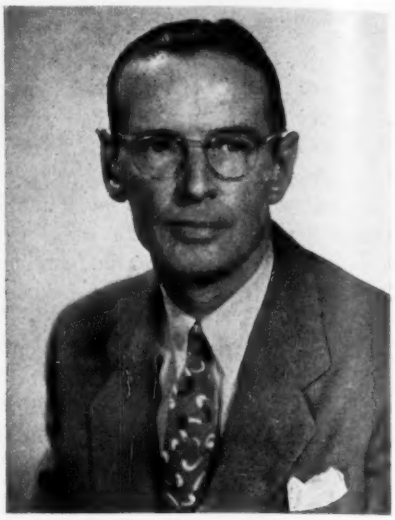
American Nickeloid Celebrates 50th Anniversary

The American Nickeloid Co., Dept. MF, Peru, Ill.

To celebrate the Golden Anniversary of the founding of the company, the American Nickeloid Company has published a booklet describing its history and present activities. This firm was a pioneer in the pre-plating of metals, and now offers to the trade a wide variety of metals with either one or both surfaces pre-plated. The booklet describes some of the many applications of their product, and is available upon request to the above address.

Lindsey Appointed by Diversey Corp.

Leonard R. Lindsey has been appointed Service Engineer for the



Leonard R. Lindsey

Metal Industries Department of the *Diversey Corporation*, 53 W. Jackson Blvd., Chicago. Lindsey will handle the sales and servicing of Diversey metal cleaning and surface preparation products in the Columbus-Dayton-Cincinnati area.

Chemical Industry Medal to J. A. Rafferty

For his leadership in developing the billion-dollar synthetic aliphatic industry, strategic field of chemical production vital to the national economy, *James A. Rafferty*, vice-president of the *Union Carbide and Carbon Corp., New York*, was awarded the Chemical Industry Medal for 1948.

The medal, conferred annually by the American Section for outstanding application of chemical research to industry, was presented at a dinner meeting in the Hotel Waldorf-Astoria, New York, on November 5, when leading scientists paid tribute to Mr. Rafferty both for his peacetime research and for his contributions to the wartime rubber and atomic energy programs.

Calgon Promotes Rice To Vice President

Owen Rice, former manager of the Calgon Threshold Department, has been elected vice president in charge of commercial chemical sales, *Calgon, Inc., Pittsburgh*, a subsidiary of Hagan Corporation.

Mr Rice joined a Hagan subsidiary, Hall Laboratories, Inc., in 1937, as a research engineer.

He has traveled throughout the

Owen Rice

United States, written numerous technical papers and appeared on many speaking platforms at engineering conferences to spread knowledge of threshold treatment with Calgon as an effective water-conditioning technique.

Mr. Rice grew up in Owensboro, Kentucky, but his family moved to Florida and he received his education there—a high school diploma at Orlando in 1927, the B.S. degree in chemical engineering from the University of Florida in 1931, and his M.S. degree on a graduate fellowship at the same university in the following year.

Mr. Rice served as assistant chemist in the Chesapeake & Ohio Railroad's water department from 1932 to 1934. From 1934 to 1937, when he joined Hall Laboratories, he was chief chemist, Pere Marquette Railroad, at Grand Rapids, Michigan.

He is a member of the American Chemical Society, the American Waterworks Association, the American Railway Engineering Association, and the Engineering Society of Western Pennsylvania, and is a registered professional engineer in Pennsylvania.

As a college undergraduate, he was elected to membership in Omicron Delta Kappa, honorary fraternity; Sigma Tau, honorary engineering society; Gamma Sigma Epsilon, honorary chemical society; and Scabbard and Blade.

RACK COATING UPKEEP: ZERO!

NO BAKING FACILITIES? You still can have the advantages of Coating 218. Let us recommend a nearby applicator who'll be happy to process your racks.

A report on Unichrome Coating "218" shows no maintenance in 6 months!

In an Ohio plant, racks on a nickel line, which included an extra severe cleaning cycle, gave this plater money-saving evidence of Coating 218's service life. For 6 months, maintenance work—always a big item—had dropped off to nothing, with the original racks still giving good service!

Have *you* tried and compared this advanced type of rack coating to see the savings possible with it? Many well-known companies everywhere, who did, have made it their standard coating. Unichrome Coating 218 has 100% solids. On baking, it forms a heavy, elastic coating that withstands rough handling and severest plating cycles. Write for full data.

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Detroit 7, Mich. • Waterbury 90, Conn. • Chicago 4, Ill. • Dayton 2, Ohio • Los Angeles 13, Cal.

Diamond Alkali Creates Technical Service Division

Broadening the scope of its customer service activities through a program dedicated to the increasingly efficient utilization of alkalies and related specialized chemicals by leading U. S. industries, *Diamond Alkali Company*, Union Commerce Bldg., Cleveland, Ohio, today announced the creation of a new Technical Service Division headed by *Walter C. Bates*, manager, and *Dr. George F. Rugar*, assistant manager.

The new organization is designed to cover all phases of service work connected with the sale and use of Diamond-made alkalies, co-products, and derivative specialty chemicals.

In making this announcement, *C. C. Brumbaugh*, general manager of Diamond's Research and Development Department, said that while the newly-formed division has been set up as an integral part of the research-development organization located at the company's Painesville plant, it will function as a separate unit manned by a staff of 21 technical people recruited from the company's Pure Calcium Products Division Technical Staff, the Research Product Development Group, and technically trained personnel previously associated with the Sales Department in Cleveland.

A native of Gallipolis, O., Bates graduated from the Carnegie Institute of Technology, Pittsburgh, in 1909

4
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METAL FINISHING
The engineering publication of the electroplating and allied industries since 1903. Its authoritative editorial content covers the metallic surface treatment market at home and abroad. 7 x 10 type page. All paid circulation at $3 per year.
ORGANIC FINISHING
The industrial product coating magazine originally part of METAL FINISHING. Covers the lacquering, enameling and painting of metal, wood and plastic products with selected paid and controlled circulation. Pocket size.
GUIDEBOOK DIRECTORY
The "bible" of the electroplating and allied industries. 17th annual edition to be published in June 1948. Pocket size and completely sectionalized. 1947 edition carried the sales message of 144 suppliers.
ORGANIC FINISHING GUIDEBOOK DIRECTORY ISSUE
Published as the April 1948 issue of ORGANIC FINISHING with regular advertising rates prevailing. Contains exclusive valuable reference material plus product and trade name Directory.
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with a B. S. degree in mechanical engineering. Prior to coming with the Diamond organization in 1929, he was employed as an engineering draftsman with Dow Chemical Company, Midland, Mich., and also served subsequently as a department manager in the Electrical Supplies and Appliances Division of General Electric Company at its Pittsburgh Branch.

Dr. Rugar, the new assistant manager of the Diamond Technical Service Division, joined the company in 1944 as Product Development Manager in the Research and Development Department following 15 years with the Hooker Electrochemical Company, Niagara Falls, N. Y., where he served successively during this period in various research, new product development, sales promotion and advertising capacities.

Born in Penn Yan, N. Y., Dr. Rugar received his B. S. degree from the University of Rochester and his A. M. and Ph. D. from Columbia University, where he was elected to Sigma Xi and Phi Lambda Upsilon, honorary societies. Long active in the American Chemical Society, he is a past chairman and currently a national councilor of this organization's Northeast Ohio Section.

Dr. Rugar also is a member of several other technical organizations, including the American Association for the Advancement of Science, the American Institute of Chemists, the Chemical Market Research Association, the Commercial Chemical Development Association, the Armed Forces Chemical Association, and the Chemists Club of New York City.

DeBothezat Adds Market Specialist

DeBothezat Fans Division of American Machine and Metals, Inc., East Moline, Ill., has announced the appointment of *Harold L. Mooney* as director of market research. Mr. Mooney has a background of more than twenty years' experience in all phases of market research and in the development of manufacturing, trade and consumer research techniques. He is a member of the Market Research Council and the American Marketing Association.

Koble Trading Co. Announces Change in Name

The *Koble Trading Company* has announced that they have changed their name to the *Koble Tank Mfg. Co.* with headquarters at 173 *Arlington Ave., Clifton, N. J.* The firm manufactures wood tumbling barrels and wood liners in addition to their wood tanks. *Mr. Frank Koble* is president of the organization.

New Western Representative Appointed for Electric Products Co.

The Electric Products Company, Cleveland 12, Ohio, recently appointed *Hubert Kaub and Company, Denver, Colorado*, as agents. They are direct factory representatives covering the states of Colorado, Wyoming, Utah.

Hubert Kaub

George Kaub

New Mexico and El Paso County of Texas.

The principals of this concern are *Hubert Kaub* and his son *George*, fourth and fifth generation natives of Denver and well-versed in selling specialty electrical equipment. Both have had a broad education and wide experience, having attended the University of Colorado, and having intimate contacts with industrial equipment manufacturers.

They will handle The Electric Products Company line of industrial motive-power and hand-lift truck battery chargers, electrolytic motor-generators, synchronous motors, mine locomotive battery chargers, telephone exchange battery chargers, central station stand-by charging equipment, frequency changers and industrial dynamometers.

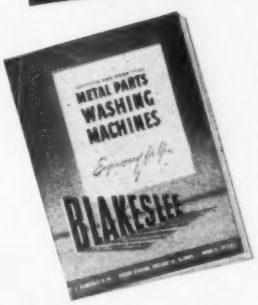
This appointment is another step by The Electric Products Company to establish and develop strategically located representatives for a nation-wide service and selling organization.

Ready for the Finishing Touch!

. . . METAL PARTS ARE MORE EASILY FINISHED WHEN CLEANED IN A

BLAKESLEE

METAL PARTS WASHER



Write today for FREE booklet on Blakeslee Metal Parts Washers to answer your particular cleaning problems.

Whether the finishing operation is enameling, lacquering, machining, plating or inspecting, your washer must do a perfect cleaning job. The Blakeslee Metal Parts Washer is especially adaptable for cleaning between operations and prior to inspection . . . Continuous and batch type metal parts washers are familiar equipment throughout the automobile and aviation industries, as well as all other metal fabrication fields.

G. S. BLAKESLEE & CO.

BLACOSOLV DEGREASERS AND SOLVENT

NIAGARA METAL PARTS WASHERS

G. S. BLAKESLEE CO., CHICAGO 50, ILLINOIS
NEW YORK, N. Y. TORONTO, ONT.

Fellowship on Porosity Established at Princeton University

The *Research Committee* of the *American Electroplaters' Society* has recently announced the establishment of a second fellowship at Princeton University to intensify the study of the nature and effects of porosity in electrodeposits.

The first fellowship, established in 1946, has already developed a unique and original method for studying porosity. The electrodeposited foil is stripped from the base metal and its permeability to a gas is measured. Experimentally, a characteristic constant for each metal is obtained. This is the time required to reduce a given pressure difference across the foil to half its original value. Preliminary work indicates that there is a linear relationship between the logarithm of the half-time and the thickness. The Research Committee believes that this method gives the first reproducible quantitative measurements on porosity that have been obtained anywhere or anytime.

Dr. Nathaniel Thon, who is the Project Director, has been very fortunate in obtaining the services of *Dr. L. Yang* as Research Associate. Dr. Yang has recently completed three years research under Professor G. I. Finch at the Applied Physical Chemistry Laboratory of Imperial College at the University of London, England. His work at the University of London was on the growth and structure of electrodeposits by electron diffraction procedures. Dr. Yang received his Bachelor's De-

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"HARRISON 4A
Buffing and Polishing
COMPOUNDS-

STAND OUT!

To make your products stand out competitively, specify HARRISON cake or liquid compounds. Their fast cutting and quick cleaning action insure economy of operation.

SPECIAL: Harrison has developed a new dip compound that creates a head on the buff. You get a deeper cut . . . use less compound . . . save!

At your request, our experienced technical representatives will call to advise you on special problems.

Cement • Buffs • Buffing and Polishing Compounds

HARRISON & CO., INC. • HAVERHILL, MASS.

gree from the National Central University of China, where he served for several years as a lecturer on general chemistry.

The members of the Project Directing Sub-Committee associated with this project are *Dr. W. A. Wesley*, Chairman, of International Nickel Company; *Mr. A. Mendizza*, of Bell Telephone Laboratories; and *Dr. B. Egeberg*, of International Silver Company.

Mandery To Head Platecoil Div.

Dan Mandery has been named to head the *Platecoil Division* of the *Kold-Hold Mfg. Co.*, Lansing, Mich.

Dan Mandery

A veteran in his field, Mandery brings to the Platecoil Division an enviable record in sales and service. His background includes many years experience in refrigeration, heating and air conditioning, covering both sales and service. After nine years in Frigidaire sales and service, Mandery moved to the *Hussman Refrigerator Co.* where he lent his talents for an eight year span. More recently Mandery has been associated with the Universal Cooler.

Mandery, as of August 1st, will give all his attention and ability to Platecoil, a medium of heat transfer, and a recent development of the company. Platecoil has a wide range of industrial uses since its serpentine or header plates may be used in building tank bottoms and sides or immersed directly into the hot bath eliminating sludge troubles prevalent with old style tank heating coils.

Carborundum Co. Makes New Appointments

Mr. E. B. Forse, presently Manager of the Refractories Division of The Carborumdum Co. at Perth Amboy, was appointed Assistant Vice Presi-

dent effective November 1, 1948. In this capacity, he will undertake special assignments relative to problems arising from the expanding markets for refractories and crude silicon carbide. For the present, his headquarters will remain at Perth Amboy.

Mr. C. E. Hawke, presently Director of Sales for The Carborundum Company, became Manager of the Refractories Division with full responsibility for the direction of this important Division's sales and manufacturing.

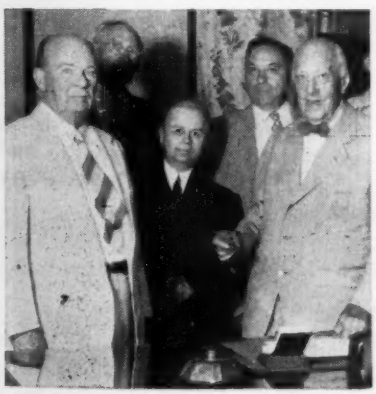
Mr. E. R. Baxter was appointed Director of Sales and Sales Administration to succeed Mr. C. E. Hawke. In his new capacity, Mr. Baxter will assume full responsibility for the direction of the field sales force and the coordination of all field sales activities with those of the various Divisions of the Company.

Mr. G. R. Rayner, Jr. was appointed Assistant Director of Sales Administration under Mr. Baxter and charged with the responsibility for the various phases of sales administration at Niagara Falls and in the District offices.

Clover Honors Its Sales Manager on His 30 Years of Service

At a recent gathering of the department heads of the *Clover Manufacturing Company, Norwalk, Conn., Mr. George A. Fish,* Sales Manager, was honored in celebration of his 30 years of continuous service with the company.

In appreciation of his outstanding record, Mr. Fish was presented with



Left to right: George A. Fish, Sales Manager; Irving S. Olmstead, Auditor; John Bowers, Mark E. Brown, E. B. Gallaher, President.

a check for $1,000. Paying tribute to Mr. Fish, *Mr. Gallaher,* President, referred to the fact that during his many years of active service, Mr. Fish has travelled in every state of the union as well as being in charge of Clover's San Francisco and Chicago offices for long periods of time. Mr. Gallaher also mentioned that Clover is particularly proud of the high esteem in which Mr. Fish is held throughout the coated abrasive industry.

The celebration was attended by Mr. Fish's associates from the home office, the company department heads, and all Clover salesmen from adjoining territories. On behalf of his fellow employees, *Mr. Charles J. Fairhurst,* Assistant to the President, presented to Mr. Fish a suitably engraved gold wrist watch as a memento of his thirtieth anniversary celebration. Following a dinner, dancing was enjoyed until a late hour.

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99.75% PURE

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Bichromate of Potash

MUTUAL CHEMICAL COMPANY OF AMERICA

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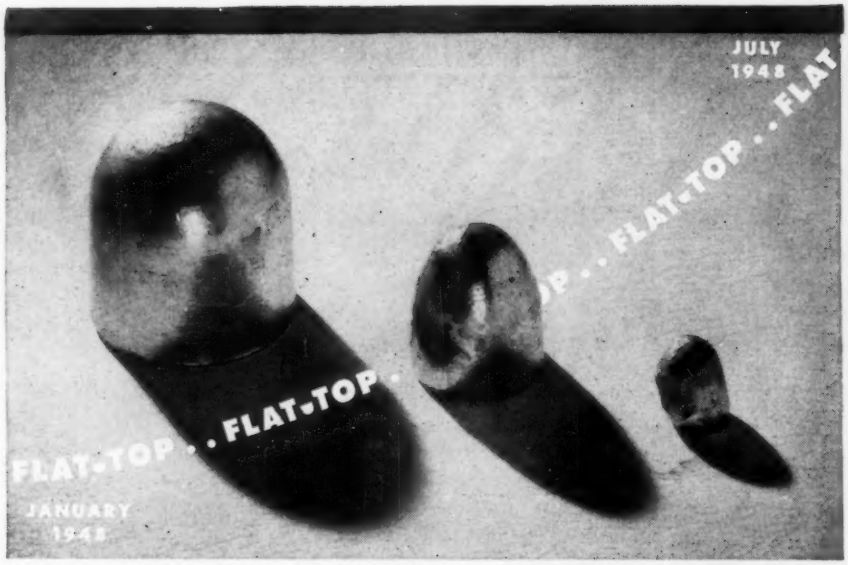
Nevins New Manager of Mathieson's Ammonia Department

S. L. Nevins has joined *Mathieson Chemical Corp.,* as general manager of the company's newly formed ammonia department, according to an announcement by *Thomas S. Nichols,* president and chairman of the board.

Mr. Nevins is credited with a number of developments in the manufacture of fertilizer chemicals, served on the sulphuric acid and super-phosphate advisory committees for the War Production Board and the Office of Price Administration during World War II, and since then has been serving on the Industry Nitrogen Advisory Committee to the Department of Commerce. He will have headquarters in Mathieson's



FLAT-TOP . . the Anode You Know is ZINC

BECAUSE ONCE A FLAT-TOP . . . *ALWAYS* A FLAT-TOP

There's a solid reason for a five-fold increase in Wagner zinc shipments since January, 1948. It's that distinctive Flat-Top shape which avoids mixing with cadmium or tin anodes. And Flat-Top retains its recognizable form right through the process. A glance at the basket tells the tale, prevents incorrect reloading, eliminates dumping, saves you labor and material.

Flat-Top is smooth, reducing hanging on basket wires. Made from highest purity zinc obtainable, 99.99+%. Sealed in wooden kegs. Sold by qualified metal-finishing supply houses in principal industrial areas.

Wagner BROTHERS INC.

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METAL FINISHING EQUIPMENT • POLISHING AND PLATING MATERIALS

Put the **FINGER** on your **Buffing Costs** *USE*

CHURCHILL FINGER-BUFFS

—AIR COOLED—

Faster Cutting — Lower Costs

Sole Mfrs.

GEO. R. CHURCHILL CO., INC.

NO. QUINCY 71, MASS.

Under U. S. Patents Nos. 2146284, 2350216. Others Pending.

S. L. Nevins

New York offices and at its Lake Charles, La., ammonia plant.

A native of St. Louis, Mo., Mr. Nevins attended the Missouri School of Mines from which he was graduated with a B.S. in chemical engineering in 1920. The following year was spent with Monsanto Chemical Co. From 1921 until he joined Mathieson he was with the Southern Acid & Sulphur Co., Inc., where he pioneered a number of new developments, including new processes for production of superphosphate and the recovery of sulphur from waste gases. Mr. Nevins was also responsible for the development of the large plant at Houston for production of ammophos and sulphate of ammonia. He is a member of the American Chemical Society, Chemists Club and Chemical Market Research Association.

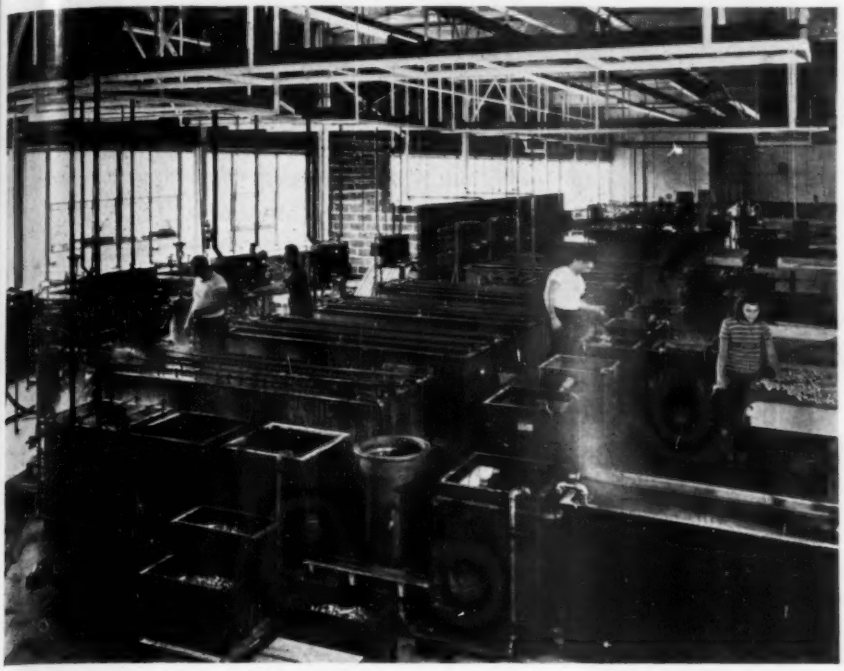
Novitsky Moves to New Quarters

Joseph Novitsky, Manufacturer of plating racks, has announced that all facilities have been moved to their new plant at 104-14 148*th Street, Jamaica* 4, *New York.*

John G. Dean Heads Industrial Chemicals Section of International Nickel

Dr. John G. Dean has been appointed Head of the Industrial Chemicals Section, Development and Research Division, of *The International Nickel Company, Inc. O. B. J. Fraser,* Assistant Manager of the Company's Development and Research Division, had been directing the Section previously.

YALE & TOWNE'S NEW HARDWARE PLATING FACILITIES



(*Photo courtesy of The Austin Co.*)

Specialty lock parts are degreased, polished, buffed, plated and lacquered in this bright, airy plating department at *Yale & Towne's* new Specialties Division lock plant at *Salem, Virginia*. Special exhaust fans installed in this area to dispose of process vapors supplement the reversible heating and ventilating system which has been used to maintain comfortable working conditions throughout the plant on a year-round basis.

Manufacturers' Literature

Coloring and Blackening Metals

Enthone, Inc., Dept. MF, 442 Elm St., New Haven, Conn.

This firm has just published a bulletin describing their line of materials and processes for coloring and blackening steel, copper, brass and zinc-base alloys. In addition to the attractive colors imparted to these metals, the coatings produced are said to provide an excellent base for painting and lacquering, or they may be wax or oil impregnated to provide a high degree of corrosion resistance. The range of colors produced on copper alloys includes gold, blue, green-brown, brown and deep black, and the finishes produced are claimed to be more durable than corresponding sulfide-type colored finishes. Small parts may be treated in baskets or in specially designed barrel equipment. Dimensional changes are practically nil, which makes these finishes adaptable to most precision parts where a durable black or colored finish

THERE IS A *Cadillac* RECTIFIER FOR EVERY APPLICATION

Electroplating - Electrolytic Cleaning, Cathodic corrosion control - Battery charging, etc.

The *CADILLAC* offers ALL of these features in EVERY size unit from 10 amperes to 5000 amperes:

1. **Smooth variable voltage control. NO TAPS.**
2. **Oversize Selenium rectifier stacks.**
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4. **Overload Protection.**
5. **Precision design and construction.**
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7. **FULLY GUARANTEED.**

Write us for illustrated literature and the name of our distributor in your territory.

Cadillac RECTIFIER CO.

3 HOWARD STREET **NEW YORK 13, N. Y.**

is required, according to the firm. Processing is relatively simple, involving only a simple immersion treatment for a few minutes.

Copies of the catalogue are available on request.

Buffing and Polishing Wheels and Compounds

J. C. Miller Co., Dept. MF, 55 Mt. Vernon Ave., Grand Rapids, Mich.

A new illustrated catalogue just issued by the above firm describes their complete line of buffs, polishing wheels, and compounds for the finishing of metals and plastics. Characteristics of the different varieties of compounds are given, with recommendations for use on specific metals. One of the outstanding features claimed for their line of compounds is the ease with which the excess materials can be removed in the cleaning cycles before plating.

A Miller specialty is the "ripple" type sewing used on one series of buffs. This "ripple" is said to provide a hard, fast-cutting buff when rotated in one direction, and a soft coloring wheel when reversed in direction of rotation.

Copies of this bulletin may be obtained by writing to the above address.

Corrosives Handling Pump Service

The Duriron Company, Inc., Dept. MF, Dayton 1, *O.*

A new 20-page Bulletin No. 815 on Model 40 Series M centrifugal Durcopumps includes their newest design features and complete exploded views of all parts. These pumps are designed and built exclusively for the handling of corrosive solutions, and every element in their construction is calculated to increase service life, ease of maintenance and ease of adjustment. Features include:

Micro adjustment of impeller.

Replaceable shaft sleeves.

Patented vent ports in the impeller to relieve pressure on the stuffing box during operation.

Full ball bearing construction.

Non-scoring Teflon seal cages.

Every pump is adaptable to an extraordinarily wide range of corrosive service, as the wet ends are available in twelve alloys and all parts can be made interchangeable. The twelve alloys are: Duriron, Durichlor, Durimet 20, Durco D-10, Chlorimet 2, Chlorimet 3, Monel, Pure Nickel, Inconel, Ni-Resist, Nickel Cast Iron and Cast Steel. This convertibility prevents pump obsolescence due to process changes, it is claimed.

Detailed information is given on such accessories and modifications as packing, lubricant, vertical seals, water jacketed stuffing boxes, strainers and claw impellers, thus making the bulletin a presentation of complete service in the handling of corrosive solutions.

Price Guide for Plating and Polishing Supplies

Udylite Corp., Dept. MF, 1651 *E. Grand Blvd., Detroit* 11, *Mich.*

This firm has just issued a new price guide of electroplating chemicals, buffing and polishing compounds, and plating and polishing equipment marketed by them. Anode prices show a rise, as does chromic acid, cleaners, cyanides, nickel salts, caustic soda. Copies are available on request to the above address.

Buffing and Polishing Wheels

American Buff Company, Dept. MF, 2414 *South LaSalle Street, Chicago, Ill.*

American Buff Company has published one of the most striking books on Buffing and Polishing Wheels in the industry. It is probably one of the finest books about a firm's products that is available in any industry.

The American Buff people call it their Golden Book of Buffs and Polishing Wheels. While it is a catalog of

CHROMIUM
NICKEL
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Simple test sets for controlling these and other solutions available.

Write for Literature

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Specify Kocour Sets from your supplier.

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American Buff Company products, it goes beyond this function to present a complete, informative text on the construction, quality and application of buffs and polishing wheels as well as the results that accrue from their various usages. This book of buffs conveys the policy and the history of one of American Industry's most unusual success stories and an exemplary manufacturing operation.

The covers are of rich, highly finished gold metallic stock, distinctively embossed. It is bound with matching gold colored plastic.

The importance of its contents is a sequence of page by page information, carefully and interestingly illustrated.

Houghton Issues New Product Index

E. F. Houghton & Co., Dept. MF, 303 W. Lehigh Ave., Phila. 33, Pa.

The above firm has issued a new attractive product index designed to guide purchasers in the various applications of Houghton products. The six page blue and white folder lists the products by trade name and their individual applications. They include such categories as lubricants, metal working, textile processing, leather oils and greases and hydraulic and transmission products.

The back cover of the new product index is devoted to a listing of Houghton's seventy-five world-wide offices.

New Fan Catalogs Offered

DeBothezat Fans Div., American Machine and Metals, Inc., Dept. MF, East Moline, Ill.

This firm has just published three new catalogs on industrial fan units.

The 24-page catalog on Axial-Flow Vent Sets, number DV-2-48, covers both volume and pressure fans, from 16" through 48" in diameter. Power-Flow Roof Ventilators are described in catalog DP-3-48. Catalog DB-4-48 gives full information on the DeBothezat Bifurcator, a fan wheel mounted in a patented split housing for exhausting corrosive or explosive fumes.

All three of these catalogs are handcomely printed in two colors and contain illustrations, specifications, dimension drawings, and certified capacity tables. Copies of any or all of them may be obtained by writing to the above address.

PERMAG

COMPOUNDS

used extensively in Job Shops and Contract work

PERMAG Cleaning Compounds are widely used in shops which have a great variety of items to prepare for finishing. PERMAG cleans all metals—all shapes—all sizes—prepares the surface for the final and permanent finish.

PERMAG is quick acting, thorough, economical in its work. Whatever metal surfaces you wish to clean—from pins to heavy castings—put PERMAG on the job; it's a guarantee of satisfaction. Glad to send you more details.

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BRIGHT NICKEL PROCESS

Produces Brilliant, Lustrous Nickel Deposits. Eliminates Color Buffing—Re-Cleaning—Re-Racking. An Ideal Base for Chromium. Excellent Throwing Power. No Special Solutions or Changes in Equipment Required. Easy to Control—Low in Cost—Successful—Practical.

Uniform results obtained on all classes of work in still tanks or mechanical barrels. Excellent for zinc die-castings. Your present cold or lukewarm nickel solution will, with the addition of LUSTREBRIGHT, produce brilliant, lustrous, adherent deposits. Guaranteed not to harm plating solution. Will not cause plate to peel, become brittle, or produce streaky deposits. Illustration shows unbuffed deposits produced before and after addition of LUSTREBRIGHT. Write for complete information.

W. C. BRATE COMPANY

14 MARKET ST. *Est. 1860* ALBANY, NEW YORK

A.E.S. Publishes Research Report No. 9 on Plating Waste Disposal

The latest Research publication of the *American Electroplaters Society*, Research Report No. 9, covers the bibliography of plating waste disposal literature. Approximately 700 references are cited in this report of Research Project 10, which is carrying out a sustained investigation at Yale University under the directorship of Prof. *B. F. Dodge*. Copies of the report are available from the *American Electroplaters Society, P. O. Box* 168, *Jenkintown, Pa.* Price 75 cents per copy.

Surface Active Agents

Atlas Powder Co., Dept. MF, Wilmington, Del.

A new booklet issued by this firm describes their line of wetting and other surface active agents for industrial uses. The booklet explains the nature of these materials, and lists various factors that must be considered when choosing a material for a specific purpose. A large number of illustrations help to make the subject easily understood, and case histories of the application of these materials to various industrial and commercial processes are described.

Copies are available upon request.

Baker Issues New Chemical Price List

J. T. Baker Chemical Co., Dept. MF, Phillipsburg, N. J.

The above firm has just issued a new price list for fine and industrial chemicals. In addition to prices, this folder gives information on packaging and freight charges from its various plants. Copies are available on request.

Electronic Control Instruments

Brown Instrument Co., Dept. MF, Wayne & Roberts Aves., Philadelphia 44, Pa.

In this 31-page catalog many schematic diagrams, photographs and dimensional drawings are used to illustrate the constructional features and operating principles of the instruments presented.

Among the instruments and systems included in Catalog No. 15-13, are the ElectroniK Strip Chart Electric Control Potentiometers, Strip Chart and Circular Chart Recorders, Precision Indicators, Strip Chart and Circular Chart Controllers, Indicating Controllers, Pryometric Switches, Thermocouple and Radiamatic Assemblies and the "Continuous Balance" principle.

Another feature of this new Brown catalog is the presentation of illustrative tables of various control forms, typical control systems, style selection tables and other data that will be helpful in the selection of proper instrumentation.

Anti-Tarnish Protection

Technic, Inc., Dept. MF, 39 Snow St., Providence, R. I.

A new folder issued by this firm describes and gives the prices of their Protectox Anti-Tarnish treatment for preventing tarnishing of metals while in storage, transit, or display. The treatment is said to leave an invisible film, and the cost of application is claimed to be less than 0.1 cents per sq. ft. of surface treated. Two solu-

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DESIGNED AND BUILT FOR
FASTER—SMOOTHER POLISHING
plus
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Backed by eighteen years experience in the abrasive polishing field, the NIEDERST BACK STAND IDLER offers the utmost in both dependability and productiveness.

Features include:
Bearing Speed Reduced 33%
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Write for Specification Sheet and information for introducing belt polishing on your present lathe equipment.

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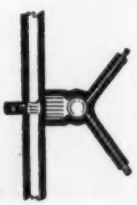

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Insulation Service
All types

Plating rack parts
copper—bronze wire

Studs—hooks—tips
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Everything for Racks

Write for price list and catalog.

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tions are required, both being made up by dissolving prepared salts in water. The first bath is an electrolytic treatment, the second a simple immersion.

Copies of this bulletin and complete details are available by writing the above firm.

Karbate Pipe and Fittings Catalog

National Carbon Company, Inc., Dept. MF, 60 East 42nd St., New York 17, New York.

An illustrated descriptive booklet covering this firm's "Karbate" brand pipe and fittings is now available. The booklet contains detailed engineering information on "Karbate" pipe and fittings, including comprehensive tables of the chemical and physical properties of the material. All pipe sizes and fittings are illustrated and cross-section drawings show dimensions, assemblies, joining recommendations and other details to aid design work and to facilitate ordering.

"Karbate" impervious graphite resists the action of most acids, alkalies and other chemicals which are not highly oxidizing in their behavior. It may be used under conditions which keep the temperature in the body of the material below 338 deg. F. (170 deg. C.); it resists thermal shock, is light in weight and has good mechanical strength, according to the manufacturer.

A copy of *Catalog Section M-88008* may be obtained by writing to the above address.

Motor and Generator Brush Standardization Booklet

National Carbon Company, Inc., Dept. MF, Room 1328, 30 East 42nd Street, New York 17, New York.

This firm is offering a booklet on Standardization of Carbon, Graphite and Metal-Graphite Brushes for Motors and Generators, which outlines a simple method of saving time and money for all users of motors and generators by illustrating how standardization can be accomplished.

Conversion from a great number of custom-built, individually ordered brushes with random specifications to a smaller number having predetermined and unified specifications will make it possible to order brushes by National Carbon Company's simplified RC Number system.

Brush standardization has saved in-

Michigan Buff "PROVEN" WHEELS

Home of Michigan Buff PROVEN Wheels

- Each buff balanced before glueing into wheel
- Made from only the best new material
- Available in any and all sizes
- Made in any densities wanted (soft—medium—hard)
- Every wheel guaranteed to run true and to be in perfect balance
- All Michigan Buff wheels are made under supervision of men of 20 years experience

Top quality new materials and modern manufacturing facilities make Michigan Buff Polishing Wheels the quality wheel of PROVEN, long-lasting performance. Your inquiries are invited!

MICHIGAN BUFF CO., INC. "PROVEN" WHEELS DETROIT MICH.

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Best Results..Lowest Cost
ON ALL TYPES OF
TANK LININGS

Years of experience qualify us to handle your specific problem . . . involving the handling of acids, alkalis, aromatic solvents, unsaturated vegetable oils, gases, vapors, etc. Engineered recommendations of Laybond Rubber, Hard Rubber, Neoprene, Koroseal, Phenolics or Ceramics. Our specialized applications include racks and hangers, anodes, pickling tanks, drums, pails, dippers, pipe and fittings, air agitation systems, tank grids and screens, coils and ventilation equipment.

REPRESENTATIVES WANTED . . . plating supply houses . . . acid and chemical companies preferred. A few select areas available. Write for details.

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LOUISVILLE 2 Manufacturers Since 1901 KENTUCKY

*PORTABLE RIGS FOR FIELD WORK

dividual companies hundreds of dollars by reducing the number of small orders and by purchasing in more economical quantities. It also effects a reduction in the number of stock items with savings in space and in handling time, less money tied up in brush stocks, and money saved on ordering, stock records and accounting.

A copy of Catalog Section B-2106 may be obtained by writing to the above address.

Bulletin on Dust Collecting

Aget-Detroit Co., Dept. MF, 398 Main St., Ann Arbor, Mich.

Description of a big capacity (suction and dust storage) dust collecting system for handling rubber and wood dusts, chips, lint and similar large bulking dusts is contained in Bulletin A-550 issued by the above firm. Bulletin contains ratings, specifications and detailed description of the operation of the Model 11B50 Dustkop which is designed to collect the dust laden air, clean it, and return it to the working space, thus saving considerable air.

Associations and Societies

AMERICAN ELECTROPLATERS' SOCIETY
Rochester Branch

The opening Fall Meeting of the Rochester Branch of the A.E.S. was held at the Rochester Institute of Technology on Friday, Sept. 17.

The Business Meeting was postponed until the last in deference to the guests from the Research Committee of the A.E.S., some of whom were in Rochester for their quarterly meeting and had to make early train connections. *President Flint* introduced *Mr. A. K. Graham*, Executive Secretary of the A.E.S., who spoke extemporaneously on the National Society and the affairs of the Research Committee. Mr. Graham introduced the following members of the Research Committee:

Dr. Wm. Blum—National Bureau of Standards, Washington, D. C.

Dr. Barney Case—Hanson-Van Winkle-Munning Co.

Mr. Guy Cole—General Motors Co.

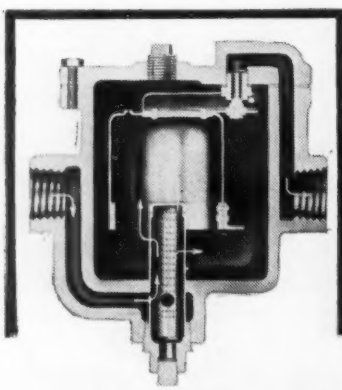
Dr. Louis Weisberg—Consultant Chairman Research Committee

Dr. Wesley—International Nickel Co.

Dr. Ralph Schaeffer — Cleveland Graphite Bronze Co.

Mr. Flint then turned the meeting over to *Walter Swanton*, R.I.T., who described the training program in Metal Finishing to be given by R.I.T. *Mr. James Weaver* described the training program in Metal Finishing to be given by R.I.T. in Electroplating which he teaches. After comment and suggestions on this program by Dr Blum and other guests, The Branch viewed the Metal Finishing Laboratory which has been installed by the R.I.T. and then returned to continue the business meeting.

Mr. Fred Wagner read the treasurer's report and the members were enthused to learn how successful the April Regional Meeting turned out. Mr. Henderchott moved that the Branch support the Research Program by donating $200.00 to the fund.



SARCO
Inverted Bucket Steam
TRAPS

Sarco Bucket Traps handle large volumes of condensate very rapidly, and can be built for the highest commercial steam pressures. The inverted bucket operates a simple valve mechanism of great power. Valve is protected by a Sarco Strainer built right into the trap. Can be equipped with thermostatic air by-pass for rapid and complete elimination of air and gas.

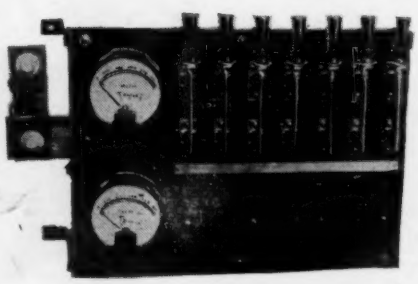
Standard sizes ½ to 2 in., 10 to 150 lbs. and 10 to 250 lbs. Forged steel types for pressures to 900 lbs. and for superheat. Catalog 350.

209

SARCO SAVES STEAM
SARCO COMPANY, INC.
Empire State Bldg., New York 1, N.Y.
SARCO CANADA, LTD., TORONTO 5, ONTARIO

HOLLAND SAYS:

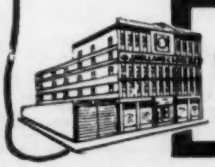
REDUCE OPERATING COSTS!



Plating Tank Rheostats.

Various sizes—with and without meters.

Write for FREE folder "P" showing our wide selection of metal finishing equipment.



J. HOLLAND & SONS, INC.
MANUFACTURERS • DEALERS
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The members voted to elect *Mr. Henry Cameron* an Honorary Member of The Rochester Branch in honor of his faithful membership of over 20 years in the Branch.

Los Angeles Branch

Launching its first step toward preparing for the national convention of the American Electro-Platers' Society, which the branch hopes to host at Los Angeles in 1951, Los Angeles Branch, at its October 13 meeting, named *Donald M. Bedwell*, superintendent of the *Hallenschied-McDonald Co.*, Los Angeles, as general chairman of the convention committee.

Howard Woodward reported that the work toward assembling data for the branch's 1949 membership directory and technical reference volume was proceeding promisingly. Indications were that a booklet of even greater scientific and reference value than the one issued by the branch in 1945 was in prospect.

Motion was made and carried to accept the recommendation of a badge committee that an identification badge be purchased for each member to be worn at meetings. The badge will contain member's name and business affiliation. An additional supply of badges will be provided for guests.

An interesting and timely program was provided by Educational Committee Chairman *Ed George*. Two speakers were offered, who presented talks on plastic plating. Introduced first was *Mayer Roter*, head of Aircraft Plating & Finishing Co., Burbank, Calif., who spoke on "Plating on Plastics in the Job Shop."

He cited various items made of plastic which lend themselves to plating and polishing, including auto accessories, airplane parts, electric contact parts, costume jewelry, bottle caps, display picture frames, etc. Among the non-metallic materials that can now successfully be plated, Mr. Roter cited leather, ceramics, plaster, rubber, glass, cloth, wood. He also discussed the several methods that can be employed for sealng the surface on leather, such as waxing, lacquering or shellacing.

Mr. Roter also discussed conductors, among which he cited spraying of metallic powder, the use of silver paint, and reduction of silver.

The second speaker was *Morris Lepisto* of Acra Instrument Co., Hollywood. His discussion dealt with coatings on plastic by evaporation.

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Chicago Branch

The Chicago Branch held their October meeting at the Atlantic Hotel on October 8th. The speaker for the evening was *Mr. H. Hassel* of the *Sturgis Products Company*, who gave a talk accompanied by movies on "Roto Finishes" a method for deburring, burnishing, and polishing of metals by tumbling. 138 members and guests attended.

"Stu" Krentel of the *MacDermid Co.*, was in Chicago recently and visited many of his old friends there.

Baltimore-Washington Branch

The October meeting of the Baltimore-Washington Branch was held in Catonsville, Md., on October 12th, with 20 members attending. The speaker for the evening was *Dr. C. Fred Gurnham*, Chemical Engineering Consultant and Chairman of A.E.S. Research Project 10, Disposal of Plating Room Wastes. Dr. Gurnham gave a very interesting talk on the work of Project 10. He spoke of the need for the treatment of plant wastes to prevent pollution of streams, rivers, and water supplies; pointing out the source and degrees of pollution from plating processes. Methods of treating waste solutions of acids, heavy metals, chromates, alkalies, and cyanides were explained and evaluated.

Galvanizers to Meet in Pittsburgh

The Fall meeting of The Galvanizers Committee, sponsored by the American Zinc Institute, will be held at the *Roosevelt Hotel, Pittsburgh, Pa.*, on Wednesday and Thursday, November 17th and 18.

According to *B. P. Finkbone*, Chairman of the Governing Board, highlights of the meeting include an inspection trip through the research laboratory and plant of the Heppenstall Company on Wednesday afternoon and a tour of the Weirton Steel Company plant on Thursday afternoon.

At the morning sessions on Wednesday and Thursday, the technical and operating men present will participate in round table discussions of operating problems in the galvanizing shop. *T. P. Caine*, of the Weirton Steel Company, and his Program Committee are responsible for this section of the meeting.

A special meeting of the Committee's Governing Board and Council will be held at a dinner session on Tuesday, November 16th, the evening preceding the regular meeting which opens Wednesday morning.

Before the close of the meeting, successors will be named to fill the places of the three retiring members of the Governing Board which now consists of the following:

B. P. Finkbone, Armco Steel Corp., Chairman
F. F. Aloi, Bethlehem Steel Co.
N. E. Cook, Wheeling Steel Corp.
J. H. Crowe, Republic Steel Corp.
C. K. Lytle, Tennessee Coal, Iron and Railroad Co.
C. H. Steele, Steel Co., of Canada, Ltd.

ELECTROCHEMICAL SOCIETY

The 94th Meeting of the Electrochemical Society was held on October 14-16th at the Pennsylvania Hotel,

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New York City. The program on the 14th was a Symposium on Batteries, with numerous technical papers being given. In the afternoon a group visited the new Bell Telephone Research Laboratories at Murray Hill, N. J., Friday's program was a Symposium on Electrodeposition, with *Dr. Allen G. Gray* presiding at the technical sessions. The following papers were presented:

Electrodeposition of Gamma Manganese by *D. Schlain* & *J. D. Prater*, of the Bureau of Mines, Salt Lake City, Utah.

Coating Steel With Nickel by Immersion in Nickel Chloride Solutions, by *W. A. Wesley* & *H. R. Copson*, International Nickel Co., Bayonne, N. J.

Electrodeposition And Properties of Tin-Zinc Alloys, by *J. W. Cuthbertson* & *R. M. Angles*, Tin Research Institute, Middlesex, England.

Electrodeposition of Lead from p-Toluene Sulfonate Solutions, by *F. C. Mathers* & *J. C. Gries*, Indiana Univ., Bloomington, Ind.

Effect of Ionic Addition Agents on Polarization of Copper Electrodeposition, by *T. B. Lloyd, M. R. Lauver, & F. Hovorka.*

Effect of Pressure on Current Efficiency of Copper Deposition from Cyanide Solutions, by *Roy E. Webb* & *H. B. Linford*, Columbia Univ., N. Y. C.

Electrodeposition of Germanium, by *Colin G. Fink* & *V. M. Dokras*, Columbia Univ., N. Y. C.

Electrodeposition of Cobalt-Tungsten Alloys from A Citrate Bath, by *W. E. Clark* & *M. L. Holt*, Univ. of Wisconsin, Madison, Wisc.

Electrodeposition of Nickel from Phosphate Baths, by *E. S. Roszkow-*

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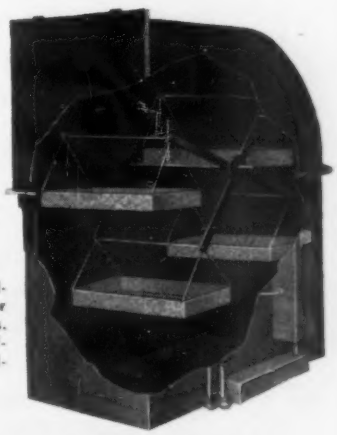

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ski & *C. B. F. Young*, Brooklyn Polytechnic Inst., Brooklyn, N. Y.

Deposition of Tungsten and Iron from Ammoniacal Citrate Bath, by *M. H. Lietzke* & *M. L. Holt*, Univ. of Wisconsin, Madison, Wisc.

Physical Properties of Iron Deposited from Chloride Baths, by *I. Larson, R. W. Moulton*, & *G. L. Putnam*.

Electrodeposition and Electrochemistry of the Deposition of Synthetic Resins, by *Colin G. Fink* & *Morris Feinlieb*, Columbia Univ., N. Y. C.

Electrodeposition of Metals from Fused Quaternary Ammonium Salts, by *F. H. Hurley* & *T. P. Weir*.

At the Friday Noon Luncheon, the guest speaker was *Dr. Spedding*, Director of the Ames Laboratory of the Atomic Energy Commission, who gave a very interesting and enlightening talk on the electrochemical problems involved in the field of atomic energy utilization.

Saturday's session was devoted to a Symposium on the Electrolytic Production of Metals, when papers were presented on the electrolytic methods for producing Aluminum, Zirconium, Tungsten, Lead, Manganese, Chromium, and Magnesium.

News from California

The factory facilities and general officers of *Vickers Electrical Division* (formerly the Selenium Corp.) were moved October 1 from El Segundo, Calif., to St. Louis, Mo., where the firm now occupies space jointly in a building with the Benwood-Linze Co.

J. E. Yarmack, formerly sales manager at El Segundo, has severed his connection with the firm. Executive personnel transferred to the new St. Louis headquarters includes General Manager *J. F. Garwood*, and advertising manager *Bert McCloud*.

The *Neal Feay Co.* of Santa Barbara, Calif., specialists in the manufacture of small aluminum products and one of the leading West Coast practitioners of the Alumilite color process, has cooperated with the *Langley Corporation* of San Diego, Calif., in the installation of a new anodizing setup in the Langley plant.

In the past the Neal Feay Co. has done anodizing Alumilite color work for Langley. For the present, the firm announced, it is planned to continue the work in both the Santa Barbara and San Diego plants until the Langley Corporation is in position to take care of all its own work.

San Francisco Branch of the *American Electro-Platers' Society* has taken steps for the establishment of a class for apprentice platers. *Fred R. Dartt*, branch secretary, reports that a special committee was recently appointed to discuss the matter with representatves of the San Francisco Central Trades School. Serving on the committee are Past-president *Fred Huntington*, *Frank Cavallera* and *Larry Miller*.

R. A. Emmett, president, and *A. O. Thatcher*, vice-president and general manager of the *Detrex Corporation, Detroit, Mich.*, spent several weeks in California on a business trip during September, making a survey of markets and manufacturing facilities on the Pacific Coast. They made their headquarters at the Detrex Corporation offices in Los Angeles and San Francisco. Following the conclusion of their California visit, Mr. Emmett

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Martvig Moll, Hanson-Van Winkle-Munning Co.
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Dr. H. A. Prey, Battelle Memorial Institute.
"Outdoor Exposure Tests."

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and Mr. Thatcher visited the Hooker-Detrex, Inc., solvent production plant at Tacoma, Wash.

The interests of B. W. Morant in *Poly Products, Pasadena,* have been acquired by *Robert R. Gordon* and *Gary Gordon,* father and son. The Gordons, now sole owners, have considerably expanded the plant at 2032 *East Walnut St., Pasadena,* for the manufacture of ball-bearing polishing machines, such as polishing heads for the metal finishing trades, saw arbors for the wood-working industry, buffing handles, etc.

The firm specializes in equipment for light buffing jobs in the plating and industrial finishing fields. Its multi-purpose polishing lathes, they report, are designed to serve a variety of uses in the plating shop. The Gordons point out that their tapered spindle is usable in various light buffing applications, and will function satisfactorily on light work while giving good access to the work and wheel.

NEW BOOK

Electrolytic Polishing and Bright Plating of Metals

By S. Wernick, Ph.D., M.Sc. Published by Alvin Redman, Ltd., Whitfield Place W-1, London, Eng. Price $6.10 plus postage.

At a time when the cost of finishing metals by the usual manual polishing and buffing methods has reached an all time high, the author of this book has presented the story of two of the most modern methods available to metal finishers to offset these high labor costs. Dr. Wernick's book points out with admirable adherence to factual data that, although the eventual and Utopian result of the application of these two techniques would be to eliminate mechanical buffing operations entirely, much further work is still necessary before this ambition

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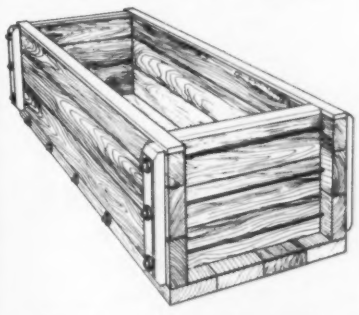
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can be realized in practice. Nevertheless, a considerable amount of work has been accomplished, and many practical applications of electropolishing are detailed. In addition, the results obtained in many experimental tests are also cited, pointing the way in which progress can be expected in the near future. For the person who wants to know what has been accomplished, and what remains to be accomplished in the field of electropolishing, this book is a valuable reference. Bright plating of metals has seen more advancement than has electropolishing, but here too much additional information is needed, and Dr. Wernick again suggests avenues of research.

The chapter on bright nickel plating is the most complete to be found anywhere, as is the very extensive bibliography of over 500 references. While the deposition of precious metals might seem out of place in a book with this title, those interested in this field will be grateful to Dr. Wernick for having made an unusually complete presentation of this subject also.

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